THE NEW YORK STATE BARGE CANAL

STATE ENGINEER AND SURVEYOR

1915

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By FRANK M. WILLIAMS, State Engineer

#48

THE BARGE CANAL SYSTEM

BEING CONSTRUCTED BY

THE STATE OF NEW YORK

New York.
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STATISTICS — BARGE CANAL.

As certain plans are still under consideration, the following figures are subject to change. All canals are meant, unless otherwise specified.

Erie branch, length of canal, not including Hudson and Niagara river termini	323.4	miles
Erie branch, number of locks	35	
Oneida lake, not included in above mileage, no improvement needed	about 19	miles
Spurs to Erie branch (Rochester and Syracuse harbors, including Onondaga lake)	9.1	miles
Champlain branch, length of canal	61.5	miles
Champlain branch, number of locks	11	
Oswego branch, length of canal	22.8	miles
Oswego branch, number of locks	7	
Cayuga and Seneca branch, length of canal (including spurs at heads of lakes)	27.2	miles
Cayuga and Seneca branch, number of locks	4	
Cayuga and Seneca lakes, portions needing no improvement and not included in above mileage	65	miles
Width of channel, land line, earth section, bottom, minimum	75	feet
Width of channel, land line, earth section, water-surface	123 to 171	feet
Width of channel, land line, rock section, bottom, minimum	94	feet
Width of channel, river line, bottom, generally	200	feet
Depth of channel, land line and minimum river line	12	feet
Locks, length between gates	338 to 343	feet
Locks, length of chamber — available length	311	feet
Locks, width of chamber	45	feet
Locks, depth of water on sills	12	feet
Dams, new	30	
Dams, old, with new crests	5	
Dams, old, used without change	5	
Bridges	290	
Boats, capacity, utilizing full lock width	about 3,000	tons
Boats, capacity, built for two to pass in most restricted channel and for two, traveling tandem, to be locked at one lockage	about 1,500	tons
Authorization of work (Erie, Champlain and Oswego canals)	Chapter 147, Laws of 1903	
Authorization of work (Cayuga and Seneca canal)	Chapter 391, Laws of 1909	
Appropriation (Erie, Champlain and Oswego canals)	$101,000,000	
Appropriation (Cayuga and Seneca canal)	$7,000,000	
Construction work begun (Champlain canal)	April 24, 1905	
Construction work begun (Erie canal)	June 7, 1905	
Excavation, preliminary (1903) estimate, not including work for dams, bridges, highway, railway, and stream changes and other small items (Erie, Champlain and Oswego canals)	132,225,800	cu. yds.
Excavation, contract plans (Erie, Champlain and Oswego canals), approximate	105,239,000	cu. yds.
Excavation, contract plans (Cayuga and Seneca canal), approximate	10,592,000	cu. yds.
Concrete, preliminary (1903) estimate (Erie, Champlain and Oswego canals)	3,243,100	cu. yds.
Concrete, contract plans (Erie, Champlain and Oswego canals), approximate	2,698,000	cu. yds.
Concrete, contract plans (Cayuga and Seneca canal), approximate	196,000	cu. yds.
Length under contract, April 1, 1915	437.8	miles
Value of work under contract to April 1, 1915 (contract prices, including alterations)	$89,213,042	
Value of work done on contracts to April 1, 1915, including extra work	$79,045,068	

NEW YORK STATE BARGE CANAL.

TO understand the canal enlargement which New York State is now engaged in, a brief glance at the history of canal-building in the state is needed. The first work of interior waterway improvement was performed by two private companies, chartered in 1792. By the end of the eighteenth century they had completed most of their works. About 1808 agitation for State-built canals was begun. In 1817 the work of construction was commenced, the main branch being completed in 1825. Within the next decade several lateral canals were built. This period was closely followed by the first enlargement of three of the chief canals,— a work protracted through many years and not completed till 1862. Then followed some two decades of little activity, during the latter part of which several of the lateral branches were abandoned. In 1884 the period of later improvements was begun by a series of lock-lengthenings, which continued for about ten years. The last two decades have witnessed the undertaking of two enlargements, the latter of which is the work now in progress — the Barge canal.

During the history of its canals New York State has opened 1,050 miles of navigable waterways, including a hundred miles of interior lake navigation. In addition there are nearly 500 miles of lake and river navigation along the Canadian and Vermont borders, and 150 miles on the Hudson river. Some 350 miles of these canals have been officially abandoned, while about 50 miles more have fallen into disuse. The work of improvement now going on, known as Barge canal construction, consists of the enlargement of four of the existing canals, large portions of the channels, however, being relocated. On one of these canals this is the second enlargement since its original building, on two this is the third enlargement, while on the other branch it is the fourth.

The four canals being improved are: (1) The Erie, or main canal, which stretches across the state from east to west, joining the Hudson river and Lake Erie; (2) the Champlain, which runs northerly from the eastern terminus of the Erie and enters the head of Lake Champlain; (3) the Oswego, which starts north, midway on the line of the Erie, and reaches Lake Ontario; (4) the Cayuga and Seneca, which leaves the Erie a little to the west of the Oswego junction and extends south, first to Cayuga lake and then to Seneca lake.

The original Erie canal was begun in 1817 and finished in 1825. It had a bottom width of 28 feet, a width at water-surface of 40 feet and 4 feet depth of water. The first enlargement was made between 1836 and 1862. At that time the section of waterway was 70 feet at water-line, 52½ or 56 feet at bottom, according to slope of sides, and 7 feet deep. The second enlargement was begun in 1896, when a depth of 9 feet was attempted, but this work was completed only at disconnected localities.

The original Champlain canal, begun in 1817 and finished in 1823, had widths of 26 and 40 feet, respectively, at bottom and water-surface, and 4 feet depth. In 1860 widths of 35 and 50 feet, respectively, at bottom and

water-line, and a depth of 5 feet were authorized. In 1870 increased widths of 44 and 58 feet, respectively, and a depth of 7 feet were ordered by the Legislature. This improvement, however, was not completed. The enlargement of 1896-8 called for a depth of 7 feet, but this work also was not completed.

The original Oswego canal, which was begun in 1825 and finished in 1828, had the same dimensions as the original Champlain, namely, 26 and 40 by 4 feet. The first enlargement was started in 1852 and completed in 1862, and gave a channel of the same size as the Erie at that time — 52½ and 70 by 7 feet. The second enlargement, that of 1896-8, was also similar to that of the Erie, a depth of 9 feet being attempted, but the work was never wholly completed.

The original prism of the Cayuga and Seneca canal, which was constructed between 1826 and 1828, was the same in size as the Erie, 28 and 40 by 4 feet. The first enlargement, accomplished from 1854 to 1862, was also similar to that of the Erie — 52½ and 70 by 7 feet. This branch did not share with the other three in the enlargement of 1896-8.

The dimensions of the present enlargement, or Barge canal improvement, are the same for all four branches of the system. Briefly it may be stated that the law requires a channel at least 75 feet wide at the bottom and having 12 feet of water. In rivers and lakes the width is 200 feet, and 72 per cent of the length of the whole system is in river or lake channel.

There are 440 miles of construction in the new canals. The 350 miles of intervening lakes or adjoining rivers make a total of 790 miles — the length of the State's waterway system of Barge canal dimensions.

In general it may be stated that the Barge canal project is largely a river canalization scheme. Previous State canals have been chiefly independent or artificial channels, built in several instances on cross-country locations. Now, however, the route returns to the natural watercourses. The bed or the valley of the Mohawk is utilized from the Hudson to the old portage near Rome. Then Wood creek, Oneida lake, and Oneida, Seneca and Clyde rivers are used, carrying the channel to the western part of the state, where the streams run north and the alignment of the old channel is retained for the new canal. The other branches of the Barge canal occupy natural streams throughout most of their lengths.

ROUTE OF BARGE CANAL.

Erie Canal. Tide-water in the Hudson river reaches to the dam at Troy. The first lock of the canal system is at this dam. A few miles above Troy the Erie branch starts west, leaving the Hudson at Waterford. It extends first through a land line of 2½ miles to the Mohawk river, the Cohoes falls in the Mohawk near its mouth making this land line necessary. Within this section boats will be lifted through 169 feet of elevation by a series of five locks, which are located within a distance of about a mile and a half and form the greatest flight of high lift locks ever constructed.

After entering the Mohawk the canal remains in the river as far west as Mindenville. To make the river navigable in this stretch ten dams are

built, two fixed and eight movable. West of Mindenville the canal alternates between land and river lines, as conditions prescribe the preferable course. The land line beginning at Mindenville ends at Rocky Rift feeder and from there a river line extends to Little Falls.

Around the falls the channel will pass in land line, occupying the bed of the present canal. Then follow a river line to Jacksonburg, a land line near the existing canal to Herkimer, a line alternating in land and river to a point west of Frankfort, where Sterling creek flows down from the north, and then a land line reaching away to the west of Rome and a little past New London, beyond which Wood creek is utilized to the eastern end of Oneida lake.

After passing through Oneida lake there will be a continuous stretch of some ninety miles in the central part of the state in which the canal will have slack-water navigation. A dam at Caughdenoy will maintain the level in upper Oneida river, Oneida lake and Wood creek, up to the land line a little west of New London. The level in the remainder of the Oneida river and the Seneca river up to Baldwinsville will be regulated by a dam in the Oswego river at Phœnix. A dam at Baldwinsville will govern the water-surface up to the Seneca and Clyde rivers to May's Point, while another dam here and one near Clyde will hold up their respective levels.

In general the natural streams are used throughout this stretch, as well as in three connecting branches — the Oswego canal, the spur to Syracuse and the Cayuga and Seneca canal. However, there will be several places where the line will be materially shortened by cutting across bends, notably at two points on the Oneida river — one near Caughdenoy and the other a little east of Three River Point. Between these two there will be a shorter straightening near Oak Orchard. The first cut-off of importance on the Seneca will be near the foot of Onondaga lake and the next occurs at Jack's Reef, where a rocky neck is channeled. Again, near Mosquito Point and in the vicinity of Fox Ridge bends are avoided. In the Clyde only the straighter reaches of the river are utilized, the windings being eliminated.

In addition to Oneida lake, already mentioned, there occur four other instances of lake navigation in the central portion of the state. Two of these are on the Erie branch and two on the Cayuga and Seneca canal. On the Erie canal the first lake utilized west of Oneida is Onondaga. This lake, together with a section of Seneca river and an artificial outlet opened many years ago, will carry a spur to Syracuse. A little farther west Seneca river encounters a peculiar conformation. Its valley spreads into a broad expanse, where a lake has been formed, which the stream enters on one side and leaves on the other. This body, which is called Cross lake, becomes the next piece of lake navigation.

The Clyde river ends in the vicinity of Lyons, but the chain of east and west streams extends a few miles farther, being continued by a tributary, Ganargua creek, to Palmyra. From this point west the land slopes generally to the north and no other stream is encountered available for the canal till Tonawanda creek is reached, some ten miles east of the terminus at Niagara river.

Since natural streams are not available, recourse must be had to an artificial channel, but the problem in this western portion of the state is somewhat simplified by the fact that the canal terminus is a body of water of sufficient size and elevation to furnish amply and without serious difficulty

all the needs of a water-supply. For the Barge canal designers the solution as to location had already been partly worked out by the engineers of the original canal, and in general the route of the early builders will be followed.

Champlain Canal. Like the other portions of the Barge canal the channel that runs to the north and taps Lake Champlain and its tributary St. Lawrence region, appropriates for its use the natural streams along its course. The present Champlain canal follows these same valleys and parallels the new route, but throughout most of its length it is an independent canal, or land line. For the new channel the upper Hudson as far north as Fort Edward will be made navigable, and this can be accomplished by building a dam about three miles north of Waterford, using four existing dams, built by private enterprise for power purposes, and erecting another dam at Crocker's Reef. In this passage to the north it has proved advisable to depart from the river at two localities — near Schuylerville and between Fort Miller and Crocker's Reef — and here short land lines have been built.

At Fort Edward the Hudson bends to the west, but a northerly course for the canal is maintained by way of a natural depression to Lake Champlain. Down the southern slope of this valley flows a small stream, Bond creek, while Wood creek runs into Lake Champlain through the northern portion. The divide between the river and lake is so low that the summit level needs to be but twenty-one feet above the river. From the Hudson to the north end of the summit level, where Wood creek is reached, a land line is being constructed, and from there the creek has been canalized by two dams, one near Comstock and the other at the entrance into Lake Champlain at Whitehall.

Oswego Canal. Seneca and Oneida rivers unite to form the Oswego river. At this confluence begins the new Oswego canal, extending thence northward to Lake Ontario at Oswego. This branch is to be almost entirely a river canalization, navigation being maintained in pools formed by existing or new dams. A new dam at Phœnix will regulate the first level. Successive pools will be governed by raised crests on the upper and the lower dams at Fulton, by a new dam at Minetto, by a new "high dam" somewhat above the "curved dam" at Oswego, which will be high enough to drown the present high dam, and by the present curved dam, which will be utilized without change. Opposite this latter dam begins the only land line on the Oswego canal. It will extend to the lake harbor, being separated from the river by a concrete wall.

Cayuga and Seneca Canal. By canalizing the Seneca river above its junction with the Clyde, the Cayuga and Seneca branch is added to the Barge canal system and Cayuga and Seneca lakes are joined to the main channel. The foot of Cayuga lake is shallow and it is necessary to dredge a channel of five miles into the lake to reach deep water. These lakes add some seventy miles of lake navigation to the State waterways. At the head of each lake there is being built a short spur, which in each instance is an enlargement of an existing channel.

TERRITORY SERVED BY CANAL.

From this description it is seen that the several branches of the Barge canal penetrate to many parts of the state. To show more clearly just what proportion of the state is within easy reaching distance of the canal, the accompanying map has been prepared. Adjacent to the line of the internal waterways that will accommodate boats of Barge canal dimensions, belts of certain widths have been drawn. Lakes Erie and Ontario and the St. Lawrence river might with propriety be regarded as parts of the waterway system, but in the present consideration they are excluded. The lines have been drawn at distances of two, five, ten and twenty miles from the waterways, and the population lying within these respective distances has been ascertained. Thus it appears that 73½ per cent of the population of the whole state is within two miles of the waterway system. In like manner it is seen that 77 per cent of the population is within five miles, 82 per cent within ten miles and 87 per cent within twenty miles.

Looking at the question from a different angle, other facts are learned. Upon the map two additional lines have been drawn — one at fifty and one at seventy miles from the waterways. These are the respective distances which motor trucks of 3½ and 2 tons capacity can cover in a day's run, going and returning. There seems to be a productive field for motor truck operation in connection with the enlarged canals, and it is anticipated that such traffic will be extensively developed. The territory within fifty miles of the waterways is 71 per cent of the area of the whole state, while that within seventy miles is 88 per cent of this total area. It is seen also that 46 per cent of the area of the whole state lies within twenty miles of its Barge canal system.

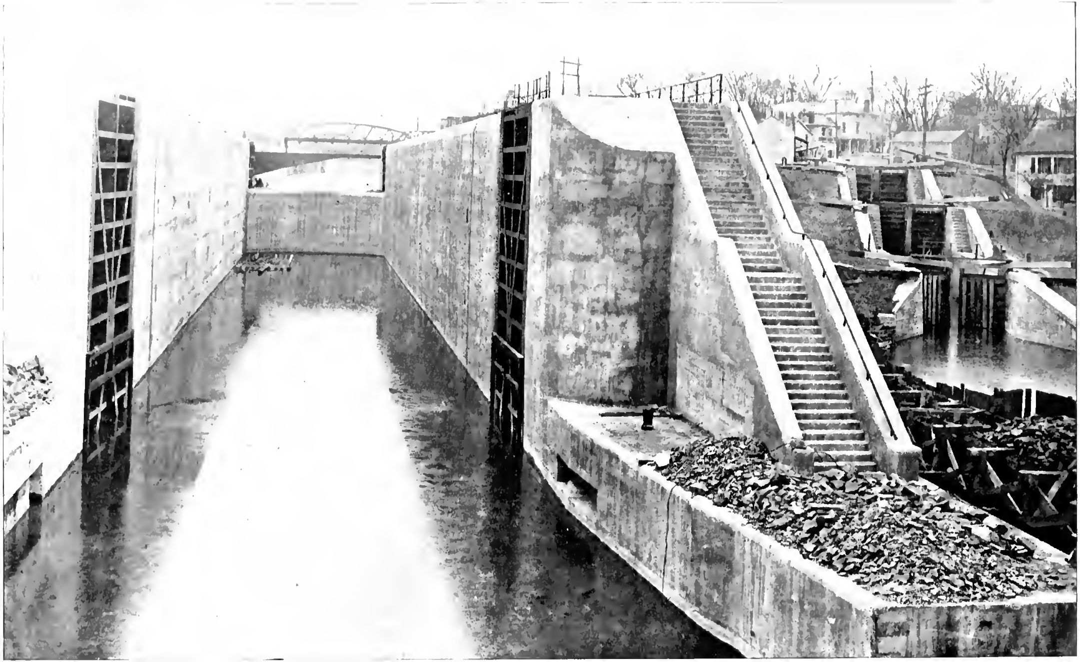
METHODS OF CONSTRUCTION.

As nearly all the work of building the new canal has been performed by contract, many methods of procedure and many kinds of machinery have been employed. These cannot be described in detail, but the accompanying photographs will give a good idea of their extent and variety.

THE LOCKS.

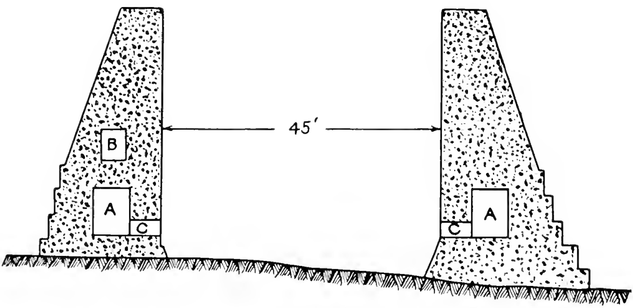
General. There will be 35 locks on the Erie branch, 11 on the Champlain, 7 on the Oswego and 4 on the Cayuga and Seneca. The standard length of lock chamber is 311 feet and this is the available length for boats. The distances between gates vary with certain conditions, the least being about 338 feet. The locks are 45 feet wide and have 12 feet of water over the sills. A guard-lock is built on each side of the crossing of the Genesee river. These locks have lift gates of the same type as the guard-gates. The gates are placed 311 feet apart and give the same available length as the other locks. They have the usual width and depth of water, 45 and 12 feet, respectively, but no normal lifts.

Completed lock in the Hudson river at Mechanicville — No. 2, Champlain canal.



Lock No. 2, at Waterford, the eastern terminus of the Erie canal. A flight of three locks of present canal dimensions is seen at the right. This is the first of a series of five high lift locks, located within about a mile and a half, which constitute the greatest flight of high lift locks in the world. The combined lifts of the five locks total 169 feet.

In addition to these, certain locks of smaller dimensions are necessary. That portion of the old Erie canal between the Barge canal crossing near New London and Butternut creek feeder is to be retained as a navigable feeder and connection is made with the new channel by a junction lock, 188 feet long between gates, 45 feet wide and with 12 feet of water. Two other junction locks join the new line to other lateral canals — the Black River canal at Rome and the Glens Falls feeder at Fort Edward. Also four locks have been built on the Black River canal where the new Delta reservoir necessitated a relocation of that channel. In order to maintain navigation on the old canal between Cohoes and Schenectady during Barge canal construction, a small lock has been constructed at the north end of Vischer's Ferry dam. This lock will be retained as an auxiliary for the passage of small boats after the completion of the Barge canal. The Act makes provision for one other lock — where the old Erie canal enters the Hudson at Albany.



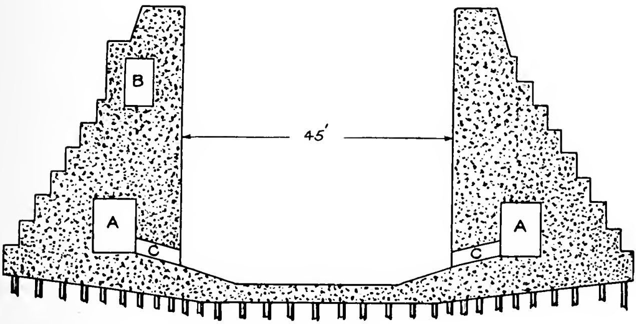
CROSS-SECTION OF LOCK CHAMBER — ROCK FOUNDATION.

A A - Culverts for filling and emptying lock.
B - Culvert for water-power development.
C C - Port-holes connecting culvert with lock chamber.

The Barge canal locks are being built of concrete throughout, both side and cross walls and floor. At a few points, where favorable rock is encountered, the concrete floor has been dispensed with. The side walls are 5, 6 or 7 feet wide at the top, according to local circumstances, and vary in height and bottom width with the lift of the lock and certain other conditions. In some cases, where one side of a lock is exposed to a river channel, the top width is increased to 12 feet. The lifts range from 6 feet to 40½ feet. Both the differences of lift and the fluctuations between normal and high navigable stages govern the heights of the side walls, which vary from 28 feet to 61 feet, with an extreme at one point of the lock at Little Falls of 80 feet. The bottom widths of these walls, which range between 13 and 34 feet, are determined by the height of the walls, the nature of the foundation and certain incidentals of design at each lock. Unless a rock or hardpan foundation can be obtained, piles are driven under practically all locks.

Lock Culverts. Within each side wall runs a culvert for filling and emptying the lock. The culverts are connected with ports that open into the chamber at the bottom of the walls. These culverts vary in size, the dimensions being 5 by 7 feet for locks of 12 feet lift or less, 6 by 8 feet for lifts between 12 and 23 feet, and 7 by 9 feet when the lift is 23 feet or more. Connected with the 5 by 7 culverts are 16 ports, 8 on either side, while the number is increased to 22 with the 6 by 8 culverts and 28 with the 7 by 9 size. The ports have been made both by imbedding cast-iron pipes in the concrete and by leaving rectangular openings in the walls, the latter being the more recent method. The area of opening in either case is about 7½ square feet each.

In some of the locks there is another culvert through one of the side walls — a feature of the hydro-electric development for operating and lighting the locks. Local conditions and the proximity of two or more locks have



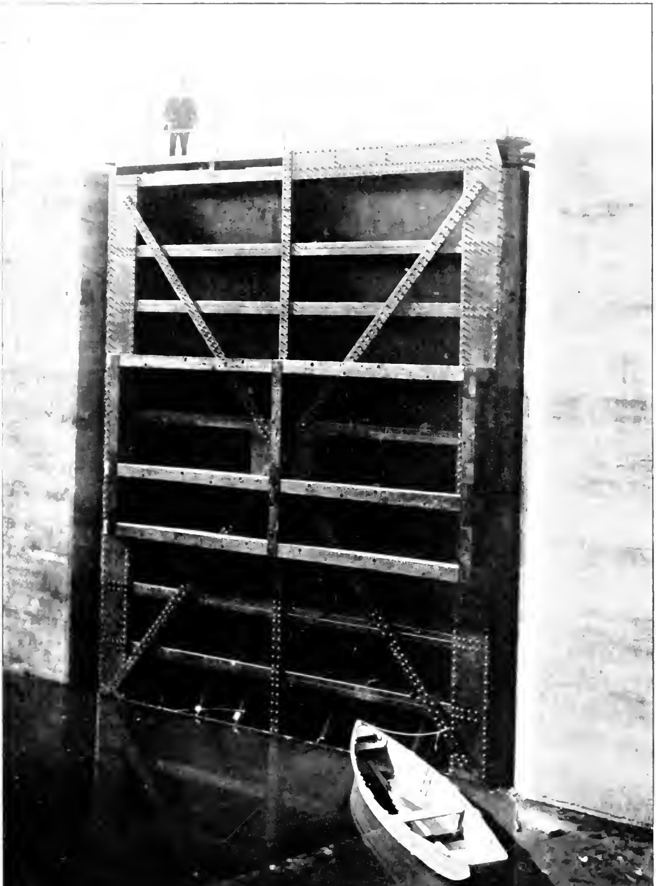
CROSS-SECTION OF LOCK CHAMBER — PILE FOUNDATION.

A A-Culverts for filling and emptying lock.
B - Culvert for water-power development.
C C-Port-holes connecting culvert with lock chamber.

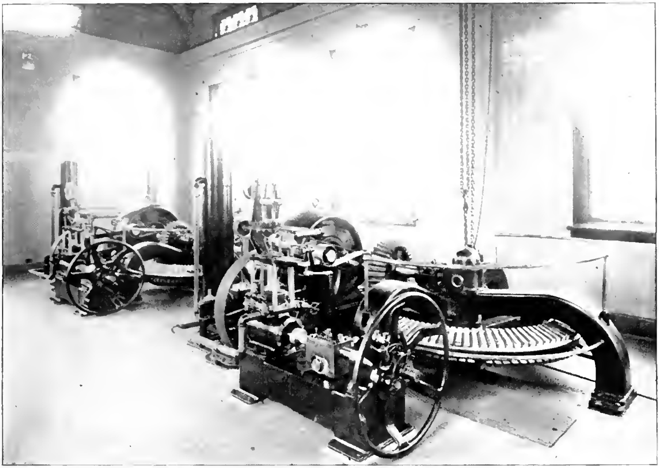
determined where these power plants shall be placed. At some points one plant will serve several locks, as at Waterford, where the series of five locks receives power from the plant at Crescent dam.

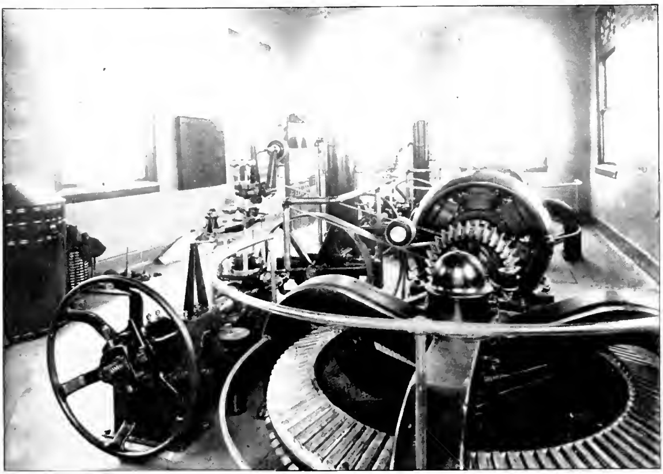
Lock Gates. The lock gates are of the mitering, girder type, carrying the principal load as beams. They are built of steel, with single skin-plates, but have white oak quoin and toe posts. The quoin post swings on a cast-steel pivot, set in the concrete, and is held at the top by an adjustable anchorage. The bearing is against cast-iron quoin plates bolted into the side walls.

Power Stations. Reinforced concrete power stations, 20 by 30 feet in plan and about 20 feet high, are constructed adjacent to the various locks. These stations with their dark green tile roofs present a very pleasing appearance. Thirty-three hydro-electric power stations, 10 gasoline electric power stations and 3 substations supply all



A lower gate of lock No. 11, Champlain canal.





Interior views of the power house at lock No. 24, Baldwinsville, showing two 50-kw., direct current, 250-volt generators, connected through bevel gearing to 100-hp. water turbines. The governor shown is a type of Lombard governor made especially for Barge canal work. Overhead is a 3-ton traveling crane. The house is lighted with four 100-watt tungsten lamps.

the power for operating and lighting the 57 locks of the entire Barge canal system. Two guard-locks, one on each bank of the Genesee river at Rochester, will be operated by power purchased from an adjacent power company.

The hydro-electric power stations, operated by water fed into the canal, are each equipped with two vertical shaft turbines, which in all but a few cases are directly connected to 50-kilowatt vertical-shaft generators, supplying direct current at 250 volts. Where power is furnished to another lock not more than two miles distant, booster sets are installed in the power stations.

The gasoline electric stations are each equipped with two generators directly connected to gasoline engines designed to operate at a speed of 600 revolutions per minute. Sufficient room has been provided for a third unit to be installed whenever a twin lock is built.

These gasoline electric generators supply direct current at 250 volts, each of these units being designed to furnish sufficient power for operating the locks and the adjacent movable dams and also for lighting approximately twelve magnetite arc lamps set about 200 feet apart on both sides of each lock and along the approach walls.

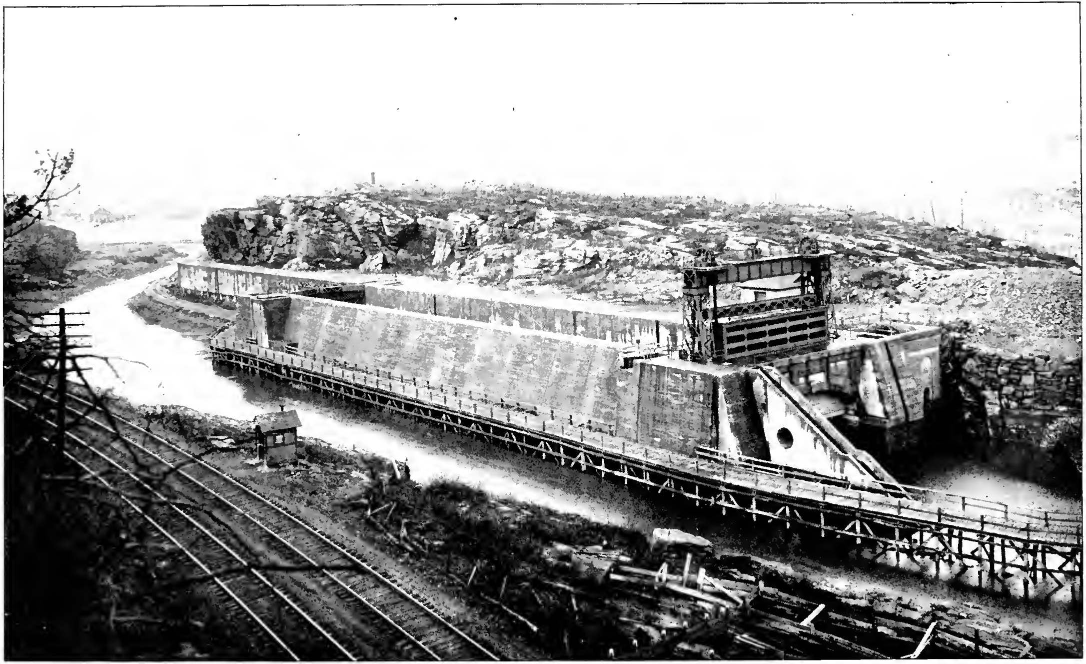
Gate Machinery. The lock gates are each opened and closed by a steel spar equipped with a heavy coil spring to absorb shock and secured to the gate by a bronze pin. This gate spar is also equipped with a rack actuated by a 7-horse-power motor acting through a train of gears designed to open or close the gates in about one minute. Resistance is supplied in the motor circuit to control the operating speed. A safety coupling, designed to release or break down whenever the load transmitted to the machinery exceeds a prescribed limit, is provided on one of the shafts.

Movement of the gates is controlled from operating stands located at each end of each lock, on the thrust walls. These operating stands are equipped with master switches of the drum type, by means of which magnet type controllers are set in motion, which automatically regulate the acceleration and speed of the motors. Limit switches are provided to arrest the motion of the gates at each end of their travel.

Signal lights indicate to the operator the position of the gates while opening or closing. In the event of failure of power or damage to the motor, it is possible to disconnect the motor and operate the gates by hand by means of sweeps provided for this purpose, which have been so designed that but two men will be required for such operation.

Valve Machinery. As has been stated, culverts of three sizes, depending on the lift of the lock, have been installed. The valves regulating the flow of water in these culverts are suspended on two chains, which pass over chain wheels near the top of the valve wells to suitable cast iron counterweights. The chain wheels are mounted on a shaft rotated by a motor operating through a train of gears designed to raise or lower the valves at a speed of about six feet per minute.

The motors of the 5 by 7 and 6 by 8 valves are rated at 3-horse-power, while those operating the 7 by 9 valves are rated at 7-horse-power.



Lock No. 17, at Little Falls. View from a hill just south of the West Shore tracks, showing also the main part of the city in the background. This is the highest lock of the Barge canal and at the time construction was begun, the highest lift lock in the world.

The movement of the valves is controlled in a manner similar to the movement of the gates. The master switches are also of the drum type and are located on the same operating stands as those controlling the movement of the gates. Signal lights indicate to the operator that the valves are fully open, two-thirds open, one-third open or closed. Like the gate machinery the valve machinery may be operated by hand, whenever this is necessary or desirable.

Capstans. Electric capstans, one at each end of each lock, are provided to control the movement of boats along the approach walls and to tow them into and out of the lock chamber. A 20-horse-power motor operates each capstan at a speed of about 60 feet per minute with a pull of 8,000 pounds. The operation of these capstans is controlled by foot switches, placed flush with the top of the lock wall in the capstans. The capstan motors, which are of the mill type and of a specially rugged design, are placed in watertight cast-iron housings, for protection against intermittent wetting by surges in the lock or other causes.

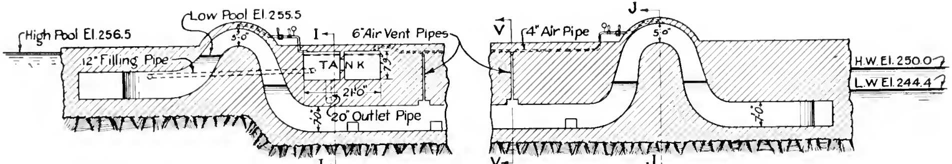
Motors. All the motors incorporated in the lock operating machinery are of the mill type, the armature and field windings of which have been designed to be fire- and water-proof.

Telephones. Telephone systems are installed connecting the several locks. These systems are so designed and equipped that it will be possible at any future time to extend them, so that a general system along the entire canal will result. Each telephone instrument can be connected to the long distance system, if this is found to be necessary or desirable.

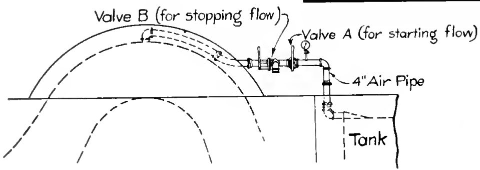
Noteworthy Locks. In the city of Oswego there has been constructed a siphon lock — the only lock of this type on the Barge canal, also the first to be built in this country and the largest employing the siphon principle yet built. The general design of the culverts is similar to that of a lock of ordinary type, except that at the upper and lower ends the culverts are curved up so as to form necks, which rise a little above the highest water-level and which at the same time are shut off from all communication with the outer air, except through the operating pipes. The flow of water is started in the siphons by means of tanks, one being built in each wall near the upper end and communicating through pipes with the upper and lower levels and with both siphons in the same wall and being shut off from all other communication with the outer air. To perform an operation the tank is first filled with water; then the intake valve is closed and the outlet valve opened. There results a body of water suspended by its weight, but tending to escape into the lower pool, thus producing the necessary vacuum. On opening the air valve, air from the siphon rushes into the vacuum and water begins flowing over the crest in the neck.

Using both siphons the lock chamber can be filled in from 4½ to 5 minutes, while it can be emptied in from 5½ to 6 minutes. It has been found that the draft of the siphon is such that soon after the flow has started the direction of the air is reversed and the vacuum is restored in the tank. Thus the operating power is self-renewing and, except for air leakage, lockages can be conducted by merely manipulating the 4-inch air valves.

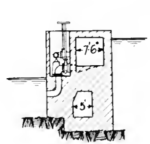
General view of the siphon lock at Oswego.



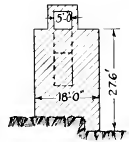
Longitudinal Section of Lock Wall



Operating Valves at Upper Siphon



Section I-I



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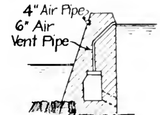
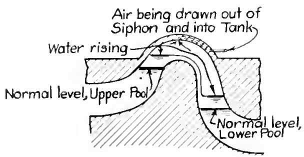
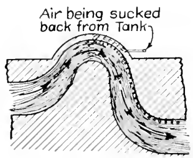


Section V-V



Starting Siphon



Siphon flowing full

Siphon being stopped

Sketches Showing Action of Siphon,
LOCK No. 8, OSWEGO N.Y.

At Little Falls there has been built a lock notable for its high lift — 40½ feet. The lower gate of this structure is of the lift type — the only instance of lift gate on any Barge canal lock, except the guard-locks at the Genesee river crossing.

At two places, Lockport and Seneca Falls, there are combined, or tandem, locks, a flight of two locks at each place. In each case also the normal combined lift is 49 feet.

THE DAMS.

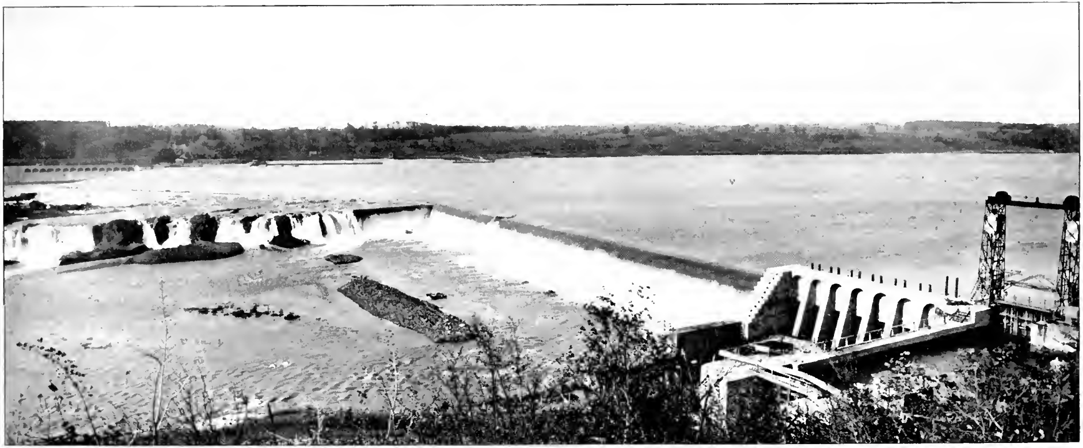
Forty dams are needed for the Barge canal. Of these a few existing dams can be used without change and a few others can be utilized by adding new

View of one of the lower siphons of the siphon lock at Oswego, showing the operating valves.

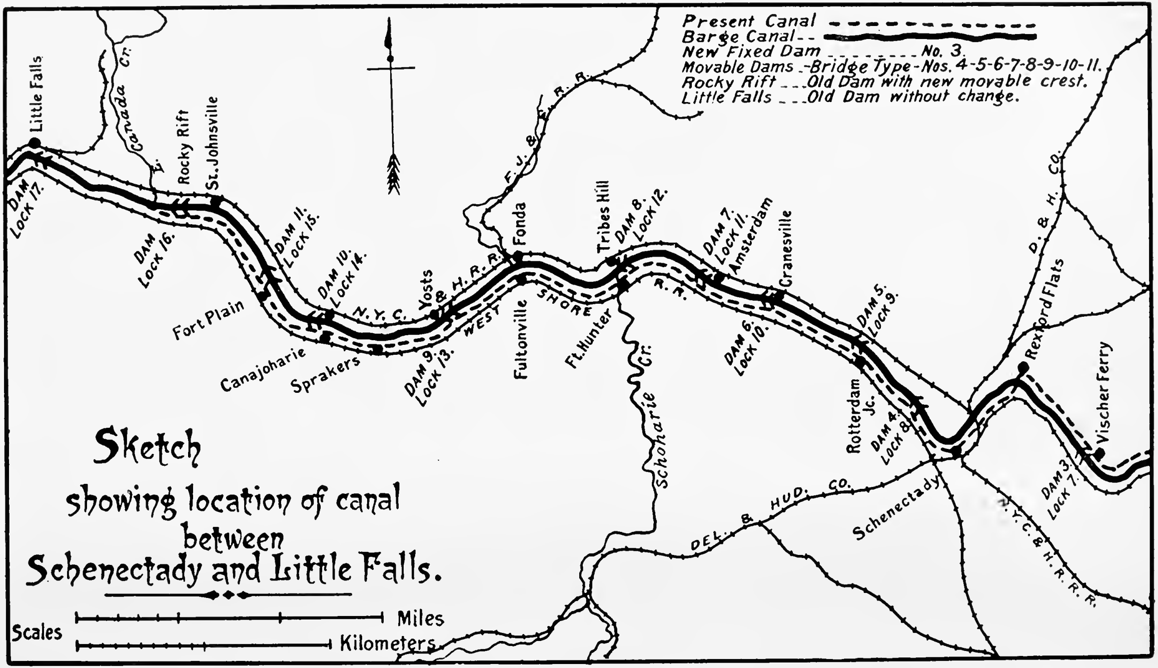
crests. Of the fixed dams the four largest are the two reservoir dams — at Delta and Hinckley — and the two across the Mohawk below Schenectady — at Crescent and Vischer's Ferry.

Crescent Dam. The Crescent dam stands at the foot of Mohawk river navigation, just below the entrance to the land line between the Mohawk and Hudson rivers. It is of the gravity, overfall type, curved in plan, its length of 1,922 feet stretching through nearly a semicircle on a radius of 700 feet. The eastern portion of the dam spans the old river channel, while the western section extends over low land that will be submerged. The crest of this dam is 39 feet above the apron. It has a width of base of 42 feet ½ inch and a top width of 11 feet 5 inches, while the apron is 40 feet wide. The pool will be raised about 27 feet above the former river level.

View from the eastern end of Crescent dam, showing the whole length of the structure.



View of Vischer's Ferry dam, showing the sections across each of the two river channels and the low section on the intervening island; also the lock at the farther end.



Sketch
showing location of canal
between
Schenectady and Little Falls.

Vischer's Ferry Dam. Vischer's Ferry dam has nearly the same sectional form as the Crescent dam, being of the same type. At this point the Mohawk is divided into two channels. The section of dam across each channel is straight and the two are connected by a low straight section built across the intervening island. In plan the dam is irregular, the main sections not being parallel nor meeting the island at points directly opposite. The whole length is nearly 2,000 feet. The width at base is 40 feet 6½ inches, on top, 11 feet 5 inches, and the height of crest above the apron, 36 feet. The apron has a width of 38 feet.

The Delta and Hinckley dams are described in paragraphs treating of the water-supply.

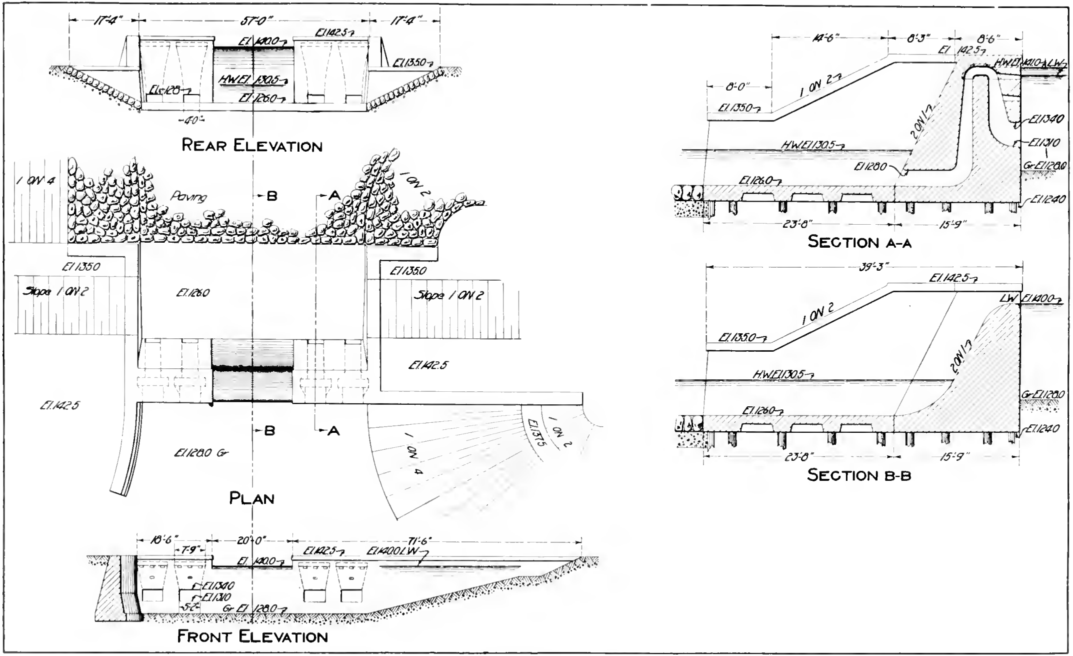
Another of the fixed dams is somewhat noticeable because of its height. This is at Seneca Falls, across the Seneca river. It creates the pool above the combined locks. Its maximum height is 75 feet.

Movable Dams —Bridge Type. Of the movable dams, the bridge type is the most prominent in point of both numbers and novelty. Eight of these span the lower Mohawk between Schenectady and Mindenville. Another is located in the Seneca river at May's Point and it is possible that one may be built in the Genesee river at Rochester, the type at this point being still under consideration. These dams have abutments, piers and superstructures like ordinary bridges, but from the downstream sides hang steel frames, resting against shoes in concrete sills that stretch across the stream between abutment and pier. The upright frames are 15 feet apart and upon them run Boulé gates, which are 30 feet wide and are placed in either two or three tiers. Electric winches, running on tracks on the bridge floor, raise the gates by means of chains, and after the gates are up they raise the frames to a horizontal position under the bridge, a pin connection at the top of the frame allowing such motion. The Mohawk dams have either two or three spans, the various lengths of span being 150, 180, 210 and 240 feet. The total lengths of these structures range from 370 to 590 feet and the depth of water between sill and upper level varies from 16 to 20 feet. At Scotia a soil was encountered that necessitated the use of pneumatic caisson construction.

Taintor Gate Dams. Another form of movable dam of which there are several examples on the Barge canal is the type known as a Taintor, or sector gate. Local conditions have governed the manner of using this style in the several localities where it has been adopted. At Cayuga and Waterloo the gates constitute the whole of the structures that are built as regulating works for Cayuga and Seneca lakes. At Phœnix and Fulton they form regulating sections in dams, the remaining portions of which are of the fixed type. At Lyons a Taintor gate fills a regulating notch in a fixed dam. At Whitehall one of these gates forms a movable crest across the top of a low fixed dam. Taintor gates are employed also in the by-passes beside the guard-gates at the head of the land line between the Mohawk and Hudson rivers. A sector gate, though somewhat different from a true Taintor gate, is placed at the spillway near Nine-Mile creek entrance.

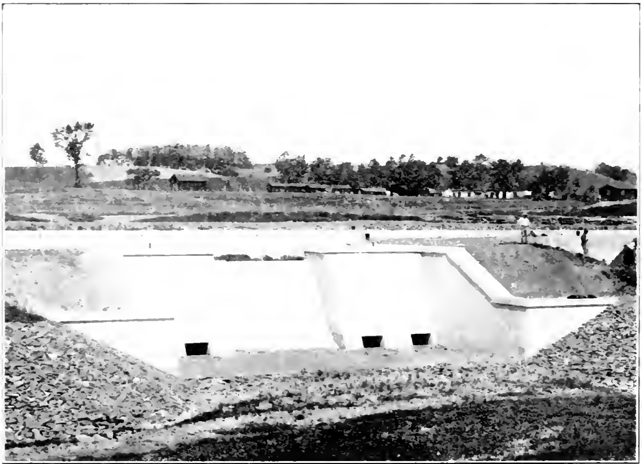
Poirée Dam. Still another form of movable dam is the one at Herkimer on the Mohawk river, which is of the Poirée type. In this dam there is a series of trapezoidal steel frames, or trestles, which are attached by pin joints to the masonry sill across the bed of the

View of the movable dam at Cranesville, showing the gates lowered and the dam in operation, maintaining the pool above.



Plan, elevations and sections of a siphon spillway.

stream and are connected at their tops, when in the upright position, by a line of removable beams. When not in use these trestles lie flat upon the sill and out of the way. The whole series is raised to an upright position by operating from the shore a heavy chain, which extends between the frames and is attached to their tops. After the trestles are connected by the removable beams, the structure is completed by placing a series of timbers, called needles, the lower ends of which rest against the masonry in the river bed, while the upper ends are against the removable bars. A bent piece of iron at the upper end of each needle fits over the bar, serving as a guide in placing the needle. The pool is regulated by removing as many needles as necessary, or by pulling them up till the lower ends are clear of the sill and swing in the current supported by the hooks. This is the first dam of the "hook-needle" type to be used in this country.



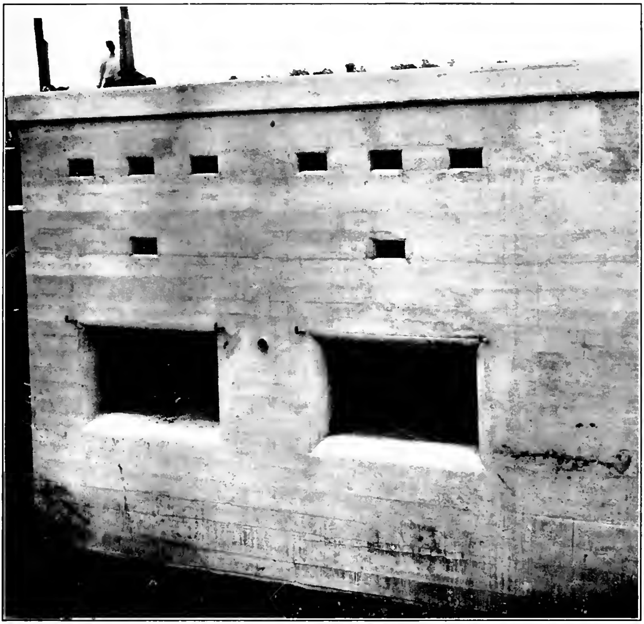
Outlets of a siphon spillway, with a short drift gap between. This structure is used to regulate automatically the water-surface in the canal where space is not available for a long spillway of the ordinary type.

Trestles somewhat like those just described are used for the low movable crest on the Rocky Rift dam. Instead of needles there are substituted Boulé gates, which in this instance are of very simple construction, being merely three tiers of 12-inch plank. With the aid of a hook to engage an eye on each plank the gates of each closure may be placed or removed by hand.

Most of the fixed dams have some movable parts that will regulate the flow of water to a greater or less degree. In some this consists simply in sluice gates which draw from the bottom of the pool. In others a regulating notch is cut in the crest and filled by some form of closure. Besides those already mentioned one such notch, that at Seneca Falls, is closed by a needle dam. Another, that at Baldwinsville, has an automatic gate — to be opened by the water itself after it passes a certain height and to close when the normal level is again reached.

OTHER STRUCTURES.

In addition to the locks and dams there are numerous other structures on the Barge canal, including bridges, aqueducts, culverts, guard-gates, retaining dams, stream entrances, spillways, waste-weirs, power plants, by-passes, break-waters, bulkheads, docks and concrete troughs. In all, the various structures on the canal number about 400. There is not space at present to do more than enumerate them, but they embrace many instances of noteworthy design and the planning of so large a number of important structures has involved a great amount of labor and care, especially as the canal is being built



Intakes and vents of two siphons of a siphon spillway, before gratings had been hung over the intakes.

through a highly developed and thickly populated territory and many and varied interests and accompanying circumstances must be considered.

Siphon Spillway.

One kind of structure only will be mentioned particularly — a new type, which was developed in Barge canal design. This structure is intended to fill the office of spillway, or waste-weir, and has been designated a "siphon spillway." It is believed that in it the siphon principle is used for the first time to create a spillway of any considerable size. The siphon action is entirely

automatic, in both the starting and stopping of the flow. This type of structure is especially adapted to certain locations on the canal — where there is not space for an ordinary long spillway and it is advisable to make the regulation of the water-surface automatic.

WATER-SUPPLY.

Throughout a considerable portion of its length the Barge canal utilizes existing natural streams, making them canalized rivers. In general the natural flow of these streams is sufficient to supply the amount of water needed to maintain the requisite depth and to perform lockages and incidental operations. To supply water for the old canals the State has built an extensive system of reservoirs and feeders. With few exceptions these are retained for the new canal and also certain new sources of supply are developed.

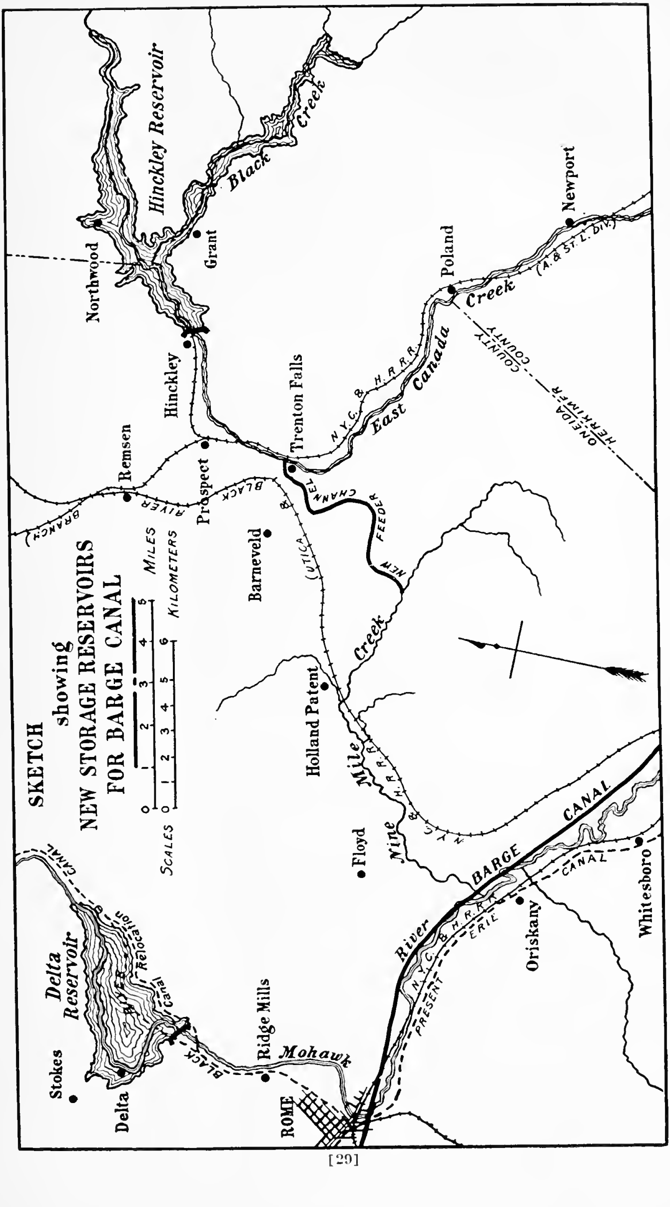
The critical points in supplying water to canals are usually the summit levels. The new Erie canal has one summit level — in the vicinity of Rome — and one half summit — at the Lake Erie end. From the Rome level there is a continuous descent easterly to the Hudson and westerly to the confluence of the Oneida and Seneca rivers at Three River Point. West of this point the canal ascends continuously to the Niagara river at Tonawanda.

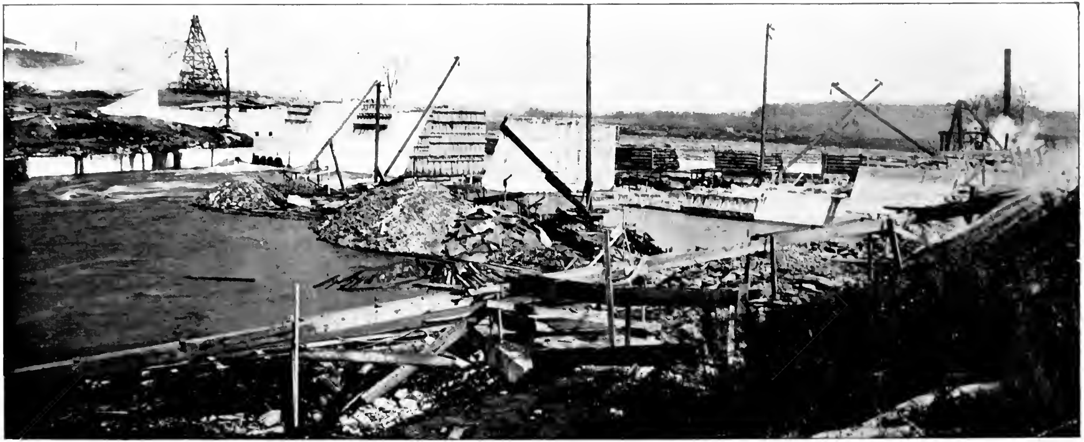
Western Section.

The greatest independent water-supply required for the Erie canal at any point is that necessary for the western section. Fortunately an almost unlimited supply is available by tapping the Niagara river. From here it is necessary to carry a continuous supply easterly to the point where the canal enters the Seneca river, near Montezuma. In order to pass this water in requisite volume, the canal bottom on the long levels has been given a proper grade, which provides for carrying at least 1,237 cubic feet per second. It is estimated that this supply is adequate, not only for 10,000,000 tons seasonal traffic, for which the Barge canal is designed, but also for the maximum traffic which the canal is capable of handling, namely, from 18,500,000 to 20,000,000 tons per season. With this ample supply from Niagara river it will be unnecessary to draw any water from either present or former feeders in the western division, such, for example, as Oak Orchard creek at Medina or the Genesee river at Rochester.

Rome Summit Level.

Although the amount of water required for the Rome summit level is less than that for the western division, the difficulties of securing an adequate supply are greater than for any other portion of the Barge canal. To furnish this level with water the existing sources of supply are retained and two new reservoirs are built. The old canal has been supplied from the north by reservoirs on the head waters of the Black river. This water has been delivered chiefly through the Black River canal. From the south, supplies have been received from Oriskany, Oneida, Chittenango, Limestone and Butternut creeks and also from certain portions of the head waters of the adjacent Susquehanna drainage basin, which have been made tributary to the Erie canal feeders through diverting channels. This entire system of reservoirs and feeders will be retained, together with such portions of the old canal as are needed to bring the waters to the Barge canal.


SKETCH
showing
NEW STORAGE RESERVOIRS
FOR BARGE CANAL
SCALES
MILES
KILOMETERS
0 1 2 3 4 5
0 1 2 3 4 5 6
Hinckley Reservoir
Black Creek
Northwood
Grant
Hinckley
Remsen
Prospect
Trenton Falls
Barneveld
Holland Patent
Floyd
Poland
Newport
East Canada Creek
N.Y.C. & H.R.R.R.
(A. & St. L. Div.)
County
Oneida
Herkimer
New Feeder Channel
(Utica & Black River Branch)
Nine Mile Creek
N.Y.C. & H.R.R.R.
Barge Canal
Present Erie Canal
River
Mohawk
Delta Reservoir
Relocation
Canal
Black
Stokes
Delta
Ridge Mills
Rome
Oriskany
Whitesboro



View showing progress in constructing the gate chambers and spillway of Hinckley dam.

Delta Reservoir. One of the new reservoirs for the Rome level is situated about five miles north of Rome, impounding the waters of the upper Mohawk river in a basin in which the hamlet of Delta was formerly situated. The dam at this reservoir contains about 90,000 cubic yards of masonry; it is 1,100 feet long, with 300 feet of spillway near the center; its maximum height is 100 feet above rock, while the overfall from crest to pool is about 70 feet, the water in the pool being at least 10 feet deep to act as a cushion to break the fall. The reservoir has an area at crest level of 4½ square miles, a maximum depth of 70 feet, an average depth of 23 feet and a capacity of 2,750,000,000 cubic feet, getting its supply from a watershed of 137 square miles.

Hinckley Reservoir. The other new reservoir is formed by a dam across West Canada creek near the village of Hinckley. This dam is 3,700 feet long, mainly an earthen structure with a concrete core wall. At the creek channel there are gate chambers and a spillway 400 feet long. The masonry contents of this dam are 110,020 cubic yards, while the embankment amounts to 611,200 cubic yards. The maximum height of masonry above rock is 82 feet and the overfall at the spillway, 61 feet. The area of the reservoir at crest level is 4.46 square miles; its maximum depth is 75 feet and average depth, 28 feet; its capacity is 3,445,000,000 cubic feet, drawn from a watershed of 372 square miles. The watersheds of both the Hinckley and Delta reservoirs lie on the slopes of the Adirondacks, the region of greatest precipitation in New York state. Since West Canada creek reaches the Mohawk valley in the vicinity of Herkimer, that portion of its flow intended for the Barge canal is diverted at Trenton Falls and carried through an artificial channel 5.7 miles long, crossing the low divide to Nine-Mile creek; thence it meets the Rome summit level near Oriskany.

Glens Falls Feeder. The Champlain canal has a summit level on the divide between the Lake Champlain and Hudson river basins. The corresponding summit of the old canal has been supplied by a feeder twelve miles long, taking its water from the Hudson at Glens Falls. This same Glens Falls feeder, improved, will supply the needs of the northern portion of the new Champlain canal, while the southern portion lies in the channel of the Hudson.

Seneca and Cayuga Lakes. Seneca and Cayuga lakes, lying at the heads of their respective stretches of the Cayuga and Seneca canal, form natural reservoirs to supply both this canal and the Erie branch between its junction with the Cayuga and Seneca canal and Three River Point.

Oswego Canal. The Oswego canal begins at Three River Point. Here Oneida and Seneca rivers unite, bringing their natural flow and also a part of the supplies from the Rome level reservoirs and Lake Erie. As the canal is chiefly in the Oswego river, its needs are amply met.

TERMINALS.

By a referendum in 1911 an important feature was added to the canal scheme — the building of canal terminals. At some fifty cities and villages along the canals and their connecting natural watercourses these terminals are to be built. The plans vary to meet the needs at each particular locality,

but in general a terminal will consist of a suitable place for dockage, mechanical devices for handling goods quickly and cheaply, a building for temporary storage and in many cases connections with adjacent railways. The purpose of the State is to furnish a place where any shipper or boatman may have the advantages of efficient terminal facilities at a reasonable cost.

CANAL ADMINISTRATION.

As the canal nears completion, the questions that arise concerning the manner and details of its operation are under consideration. The Legislature of 1912 appointed a Commission on Barge Canal Operation, with instructions to inquire into and report upon certain subjects, the following being named: Rules and regulations for operating the canal; methods of maintenance; principles for encouraging, fostering and protecting commerce; type and style of craft best suited to navigation; rules and regulations for operating canal terminals; statutory changes necessary or desirable to a proper, efficient and economical management of the enlarged canal; also any and all subjects and matters, the study of which might be expected to contribute to a wise and efficient administration of the State's waterways.

This commission has rendered its report, making many recommendations, but these have not yet received legislative attention. A subject not specified in the enactment, but one which received considerable attention by the commission, was that of the relations which should exist between the canals and railways, so that there should be an unhampered interchange of freight, a proper regulation of rates to be charged and a complete and harmonious coöperation between these two systems of transportation.

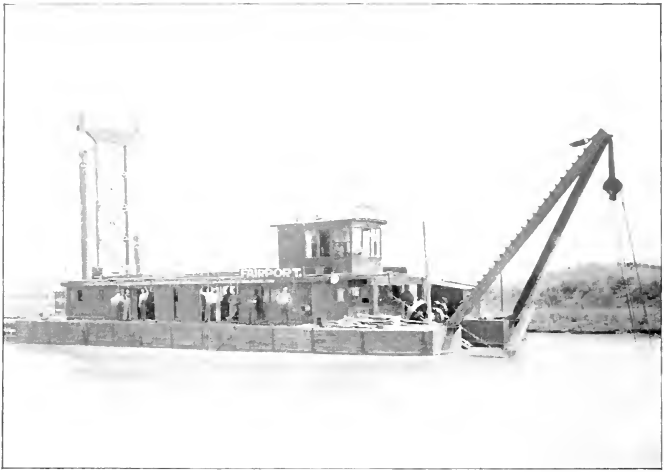
The commission reported that a generous, intelligent and aggressive policy must be pursued, if the canal system is to contribute largely toward maintaining and increasing the State's commercial supremacy and to the general wealth and welfare of her people all that they have a right to expect and all that conditions, natural and created, make possible.

BOATS.

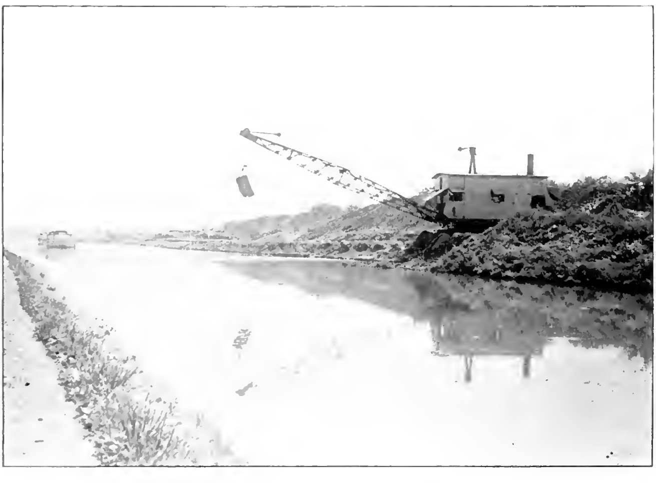
Not much can now be said concerning the boats that will ply the new canal. One of the subjects of investigation by the Commission on Operation was the type of craft best suited to navigation. There are differences of opinion among naval architects and transportation men as to the size that will be most economical. Doubtless some of these questions can be solved satisfactorily only after a certain amount of experimentation. Some of the European countries have made careful investigations along these lines and we shall profit by their knowledge. It may prove that different kinds of traffic will call for different types and sizes of boats.

If a boat is to be of such size that only one can be passed at a single lockage, probably its capacity will be 2,000 tons or more. Boats of such length that two of them may be locked through tandem and of such width that two similar boats may pass each other in the minimum canal channel, have a capacity of about 1,500 tons. Probably these would travel in pairs and 3,000 tons would be passed at a lockage. It is thought by some that a fleet of one power boat and three consorts, of such size that the four would just fill a lock, might be a better arrangement. With this fleet the lock capacity would be about the same as with the two boats, since each of the four would hold about 800 tons.

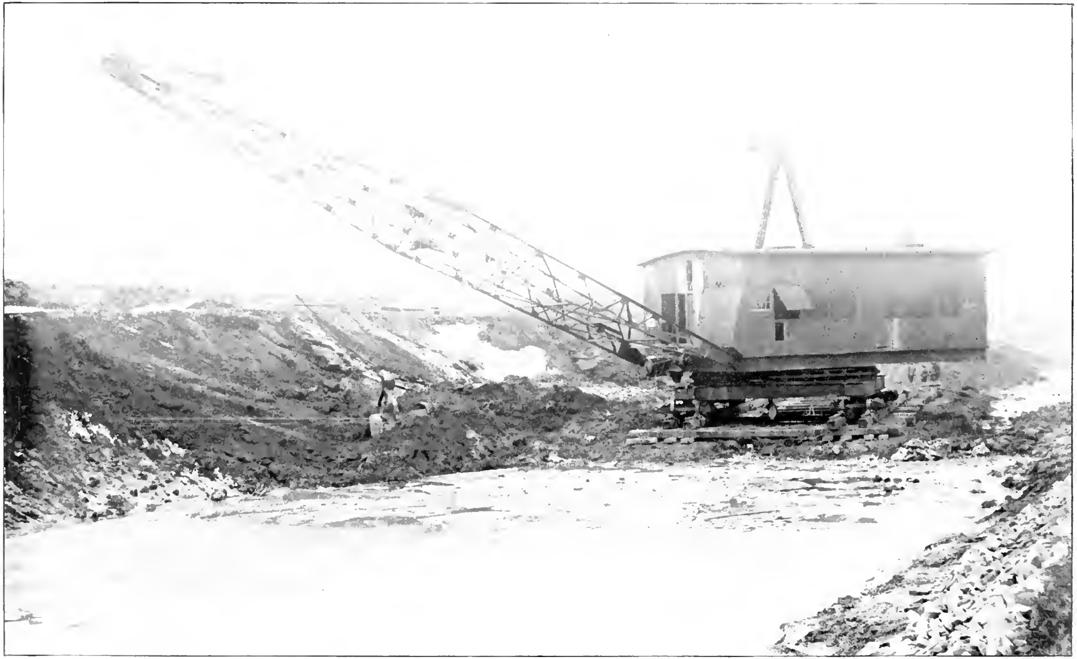
Excavation of canal prism by a double-cableway drag-line excavator.



Hydraulic dredge, operated by electric power, at work a few miles east of Rochester, where the old and new channels coincide in alignment.



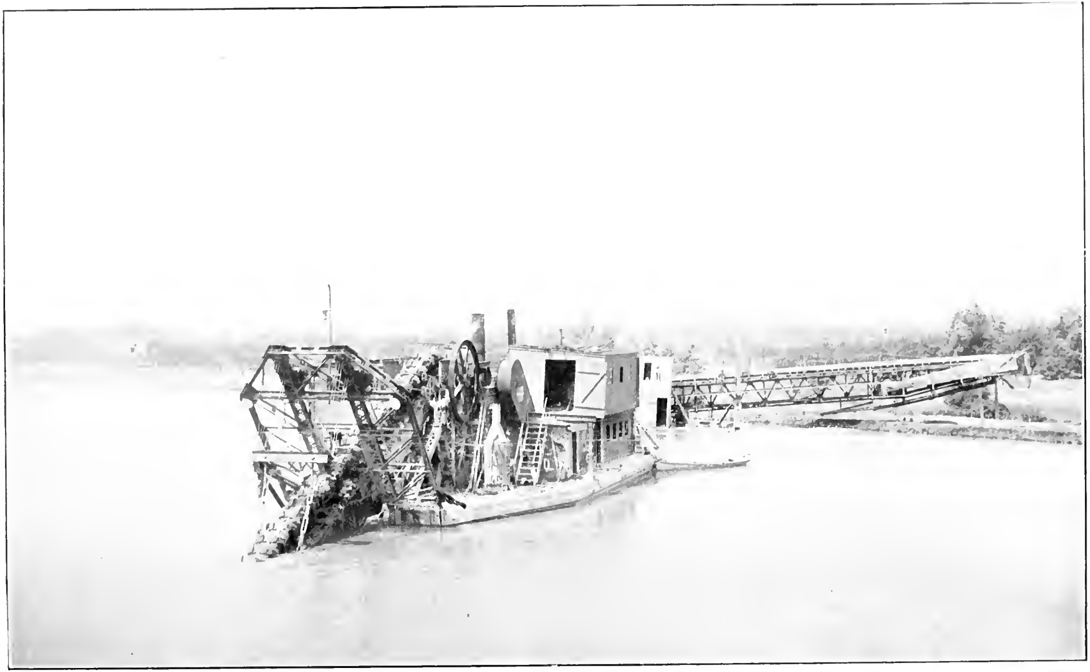
Revolving excavator, with scraper bucket, operating during the season of navigation, where alignments of old and new channels coincide.



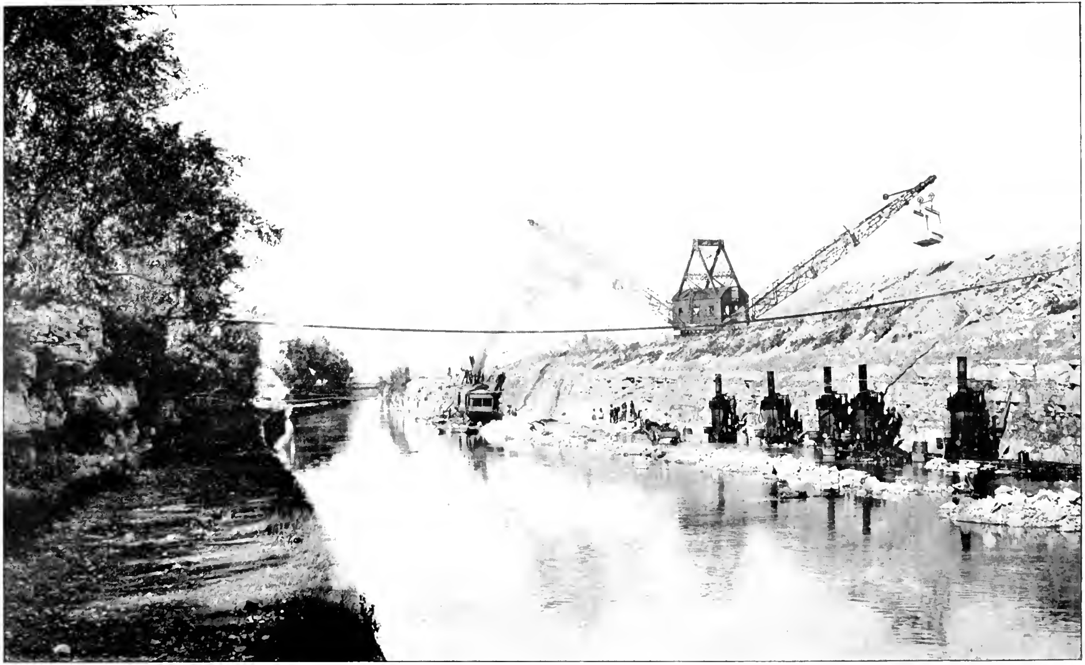
Revolving excavator, operating during the closed season, where alignments of old and new channels coincide.

Revolving excavator and tipple incline conveyor operating in the prism west of Lockport, when the water is out of the canal.

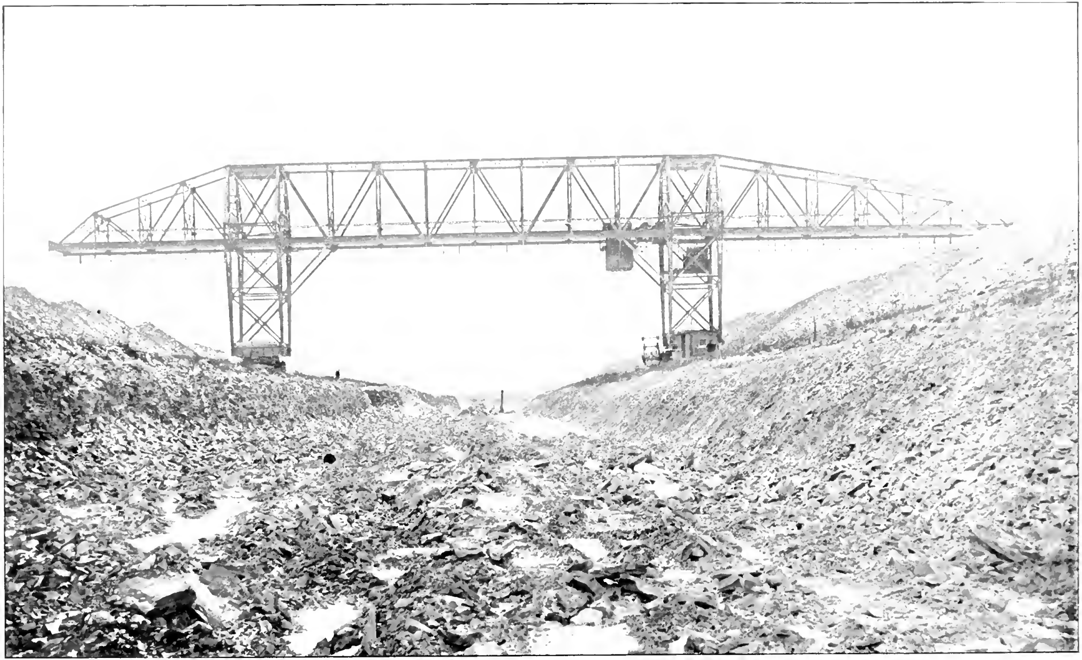
Cantilever crane, spanning channel and reaching back to spoil bank. Using a drag scraper, it has worked both with and without water in the canal.



View of ladder dredge, showing belt conveyor device for carrying excavated material to spoil bank; used during the navigation season for excavating where the new and old channels coincide in alignment.

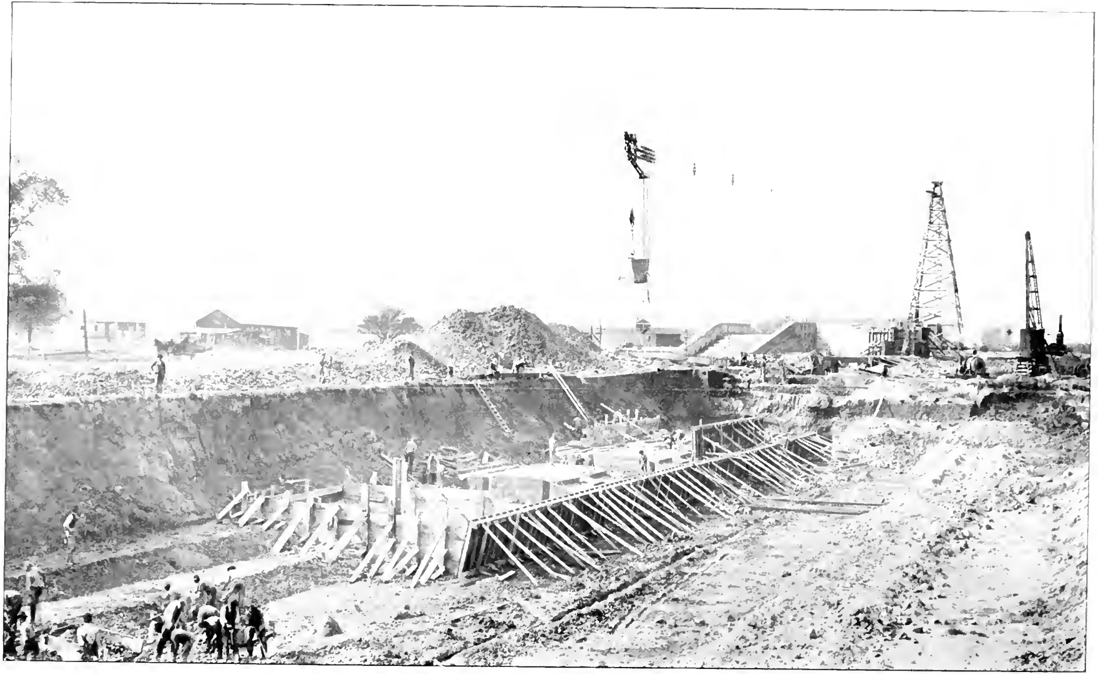


Double-boom conveyor, steam-shovel and battery of channelers widening the canal in rock cut just west of Lockport, down to water surface, during the navigation season.

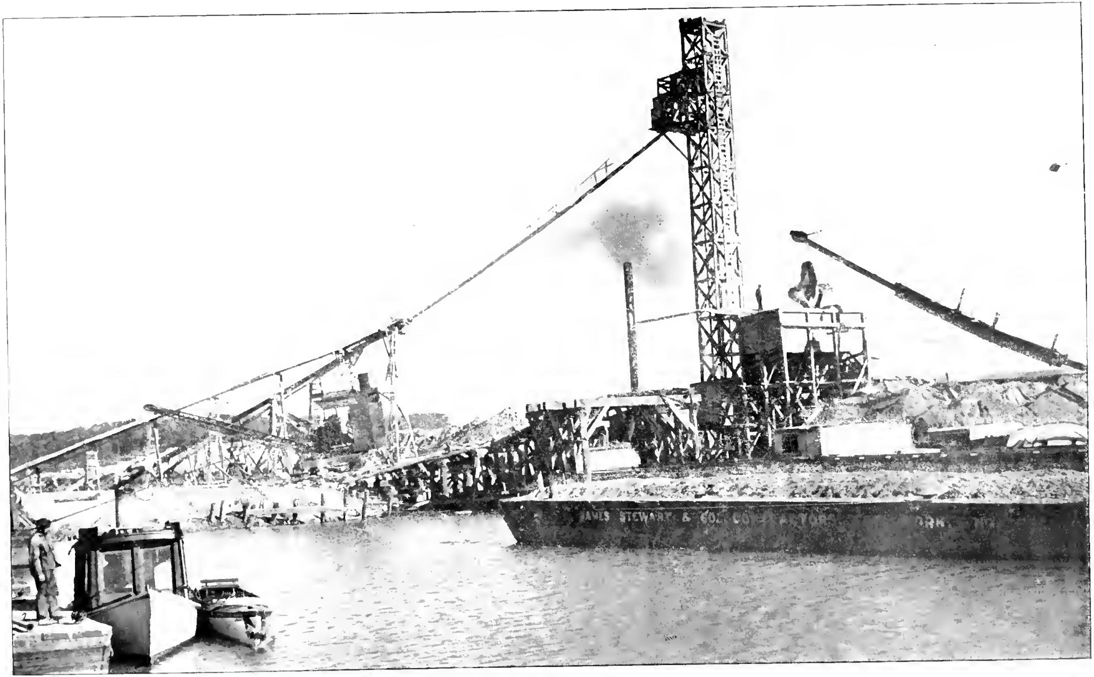


Bridge conveyor, operated by electricity, used for excavating in a deep rock cut near Rochester. Extreme length, 428 feet.

Bucket of bridge conveyor. Weight, empty, 21 tons. Capacity, 12 cubic yards.



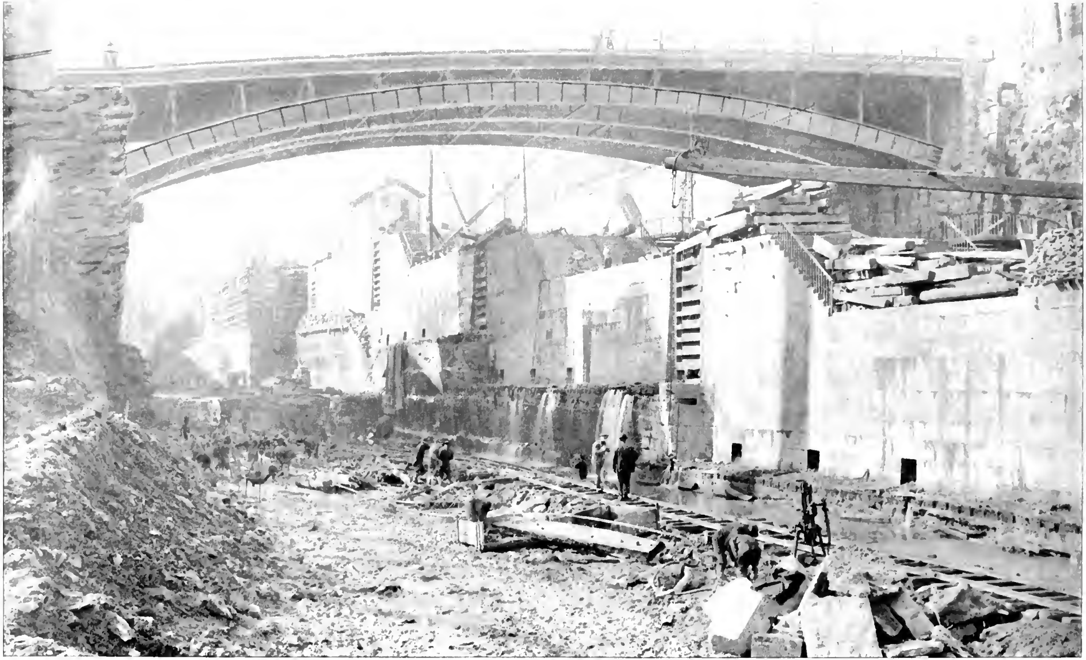
Lock No. 32, near Rochester, during early operations. The concrete was conveyed by cableway from a mixer at the foot of one of the towers. The movable tower is shown in the view.



Concrete plant at lock No. 23. A tower, with distributing chutes leading to the lock walls, is shown.

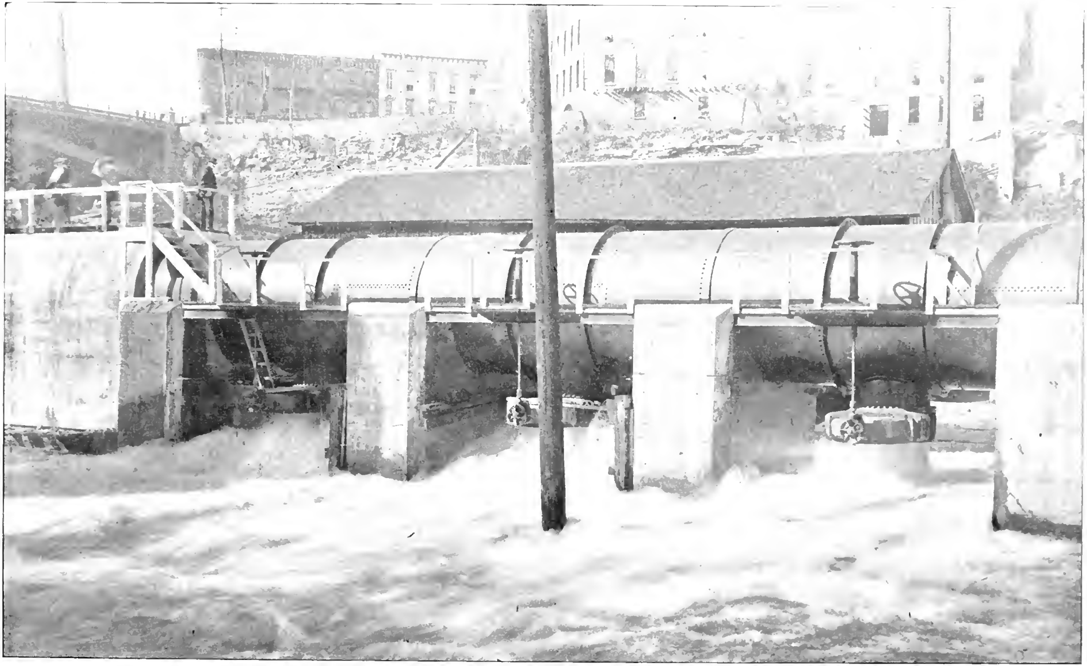
View of lock No. 3, near Waterford, showing progress in constructing the concrete floor on a rock foundation.

Concrete docking between two of the locks near Waterford. In locks of this series, which are so close together that pools are required, the docking borders the channel through the pool.

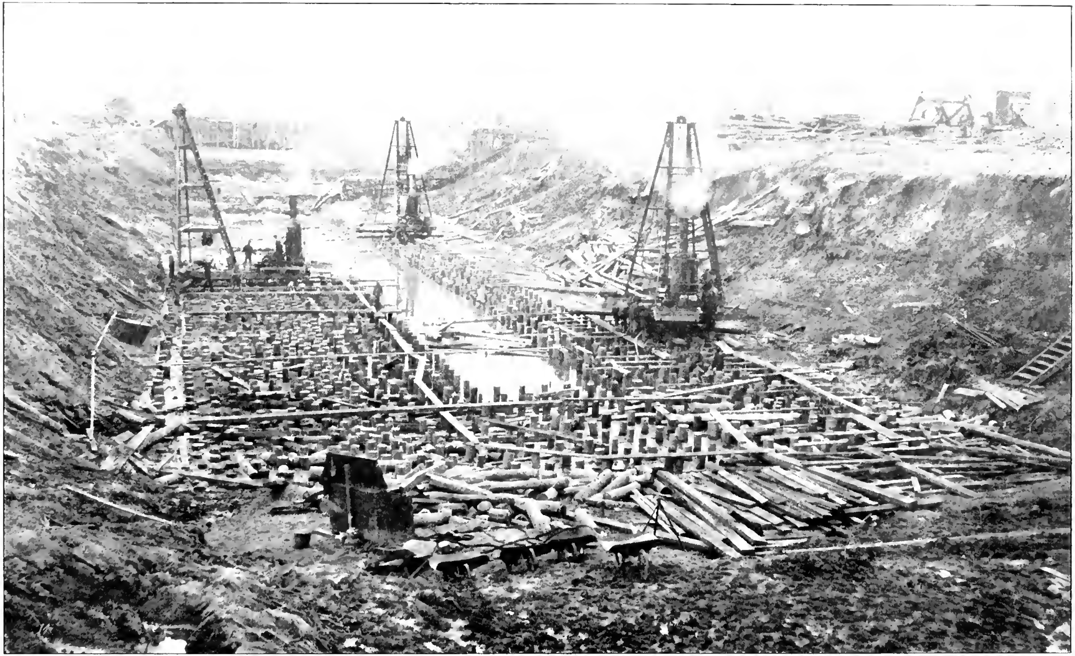


Early progress in the construction of the flight of two locks at Lockport (Nos. 34 and 35), having a combined normal lift of 49 feet. In the present canal there was a flight of five double locks. The new locks replace the south tier, the north tier caring for navigation during construction and to remain for small boats of the future. At the upper end a portion of the new side wall is seen built against the north side walls of the old south tier of locks.

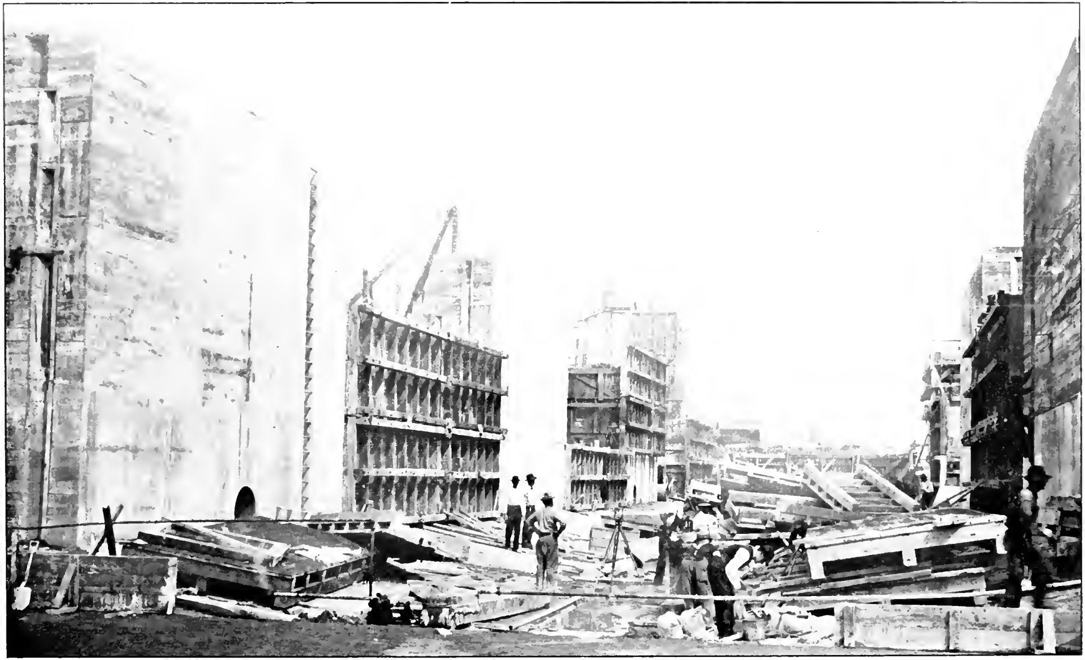
General view of the new and old locks at Lockport.



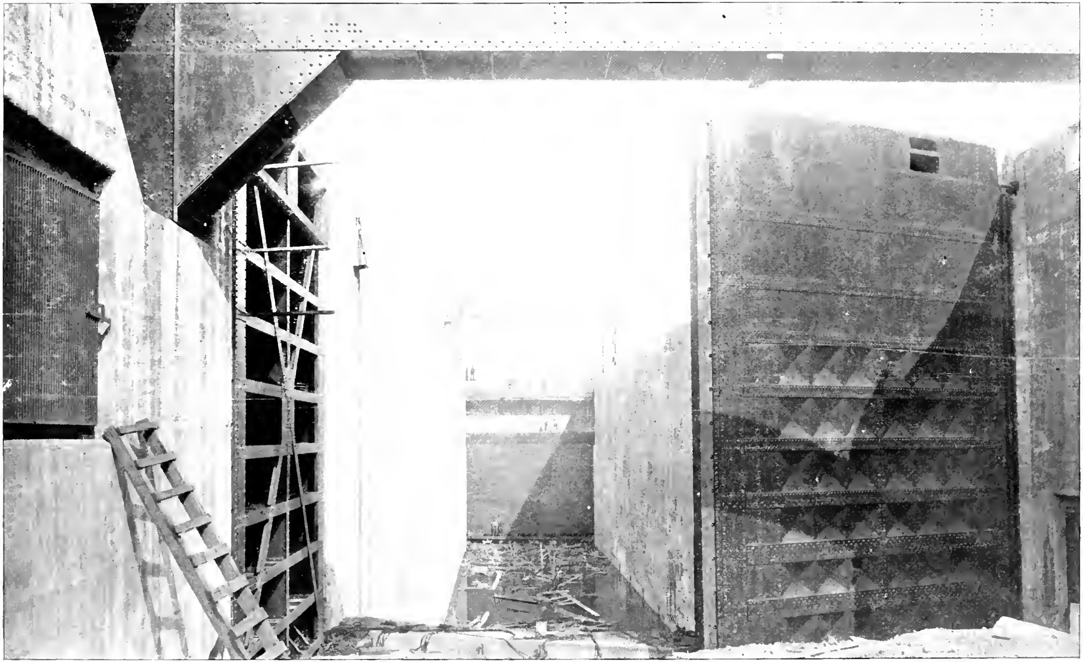
Outlet valves of the flume at the foot of the Lockport locks. Feed water is carried around the locks through a tunnel.



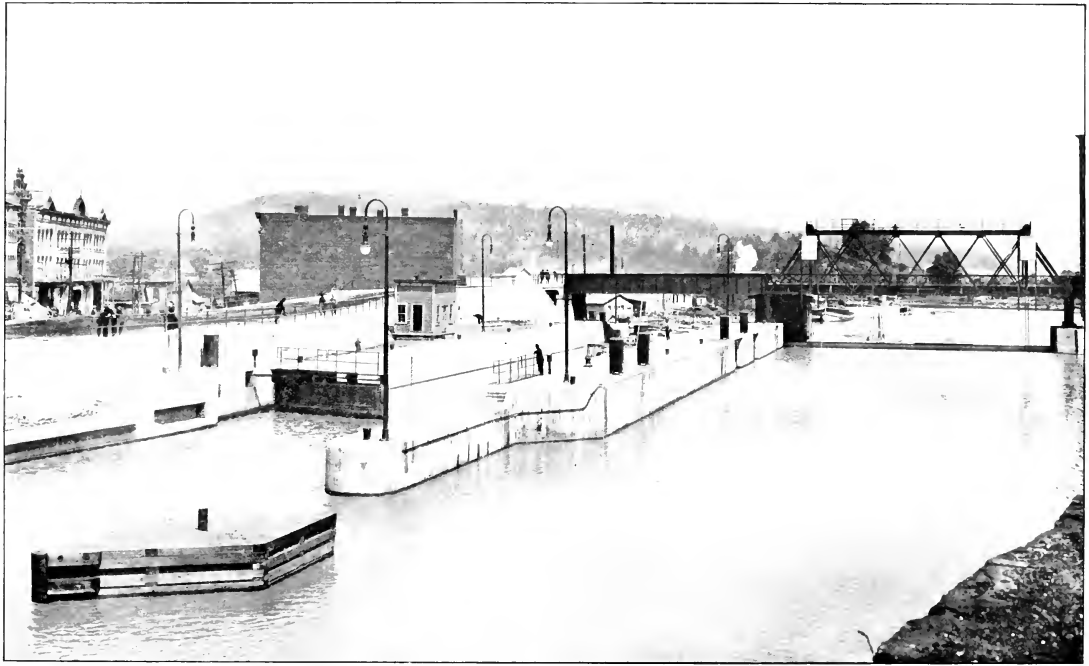
Pile foundation for lock No. 11, Champlain canal, at Comstock.



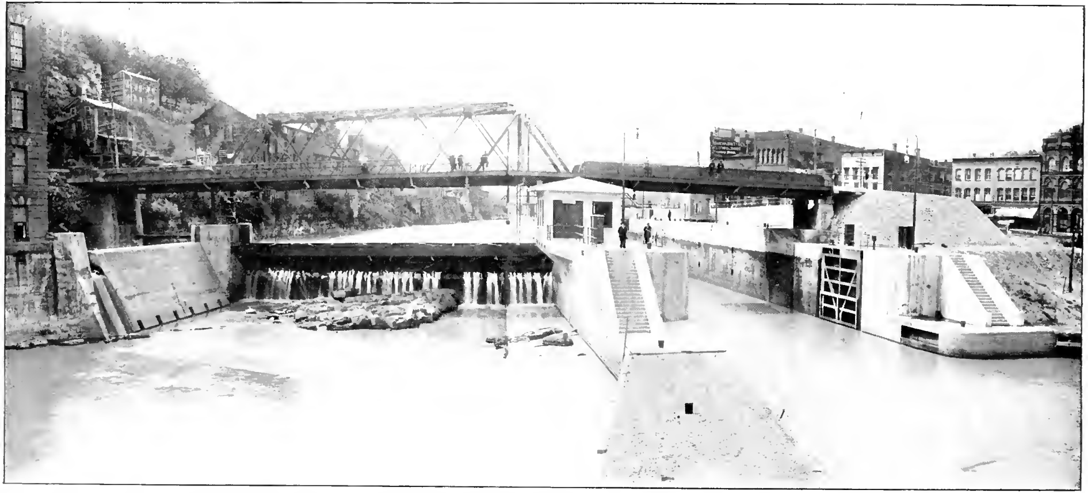
View of lock No. 8, Champlain canal, near Fort Edward, showing side walls in process of construction. The view gives a good idea of the width of Barge canal locks.



Lock No. 17, at Little Falls, of $40\frac{1}{2}$ feet lift. The lower gate, of lift type, is seen in the closed position. The high side walls and the closed upper gate make the lock look narrower than the standard width, which is 45 feet.



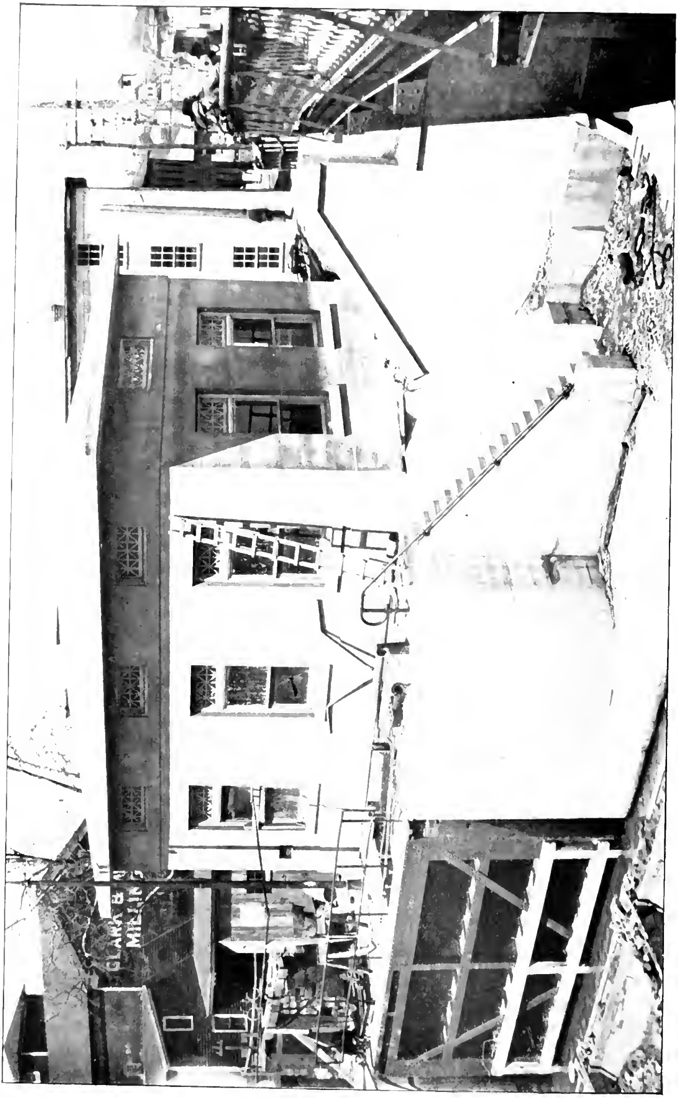
View from above lock No. 12, at Whitehall. This view shows a completed lock, equipped with hydro-electric power plant and operating machinery, which has been in full operation since the beginning of the 1912 season.



View of entrance of Champlain canal into Lake Champlain, at Whitehall, showing a siphon spillway on the left, a dam in the center with a movable crest of Taintor gate type, which is operated from the highway bridge and regulates Wood creek, and lock No. 12 with its power house on the right.

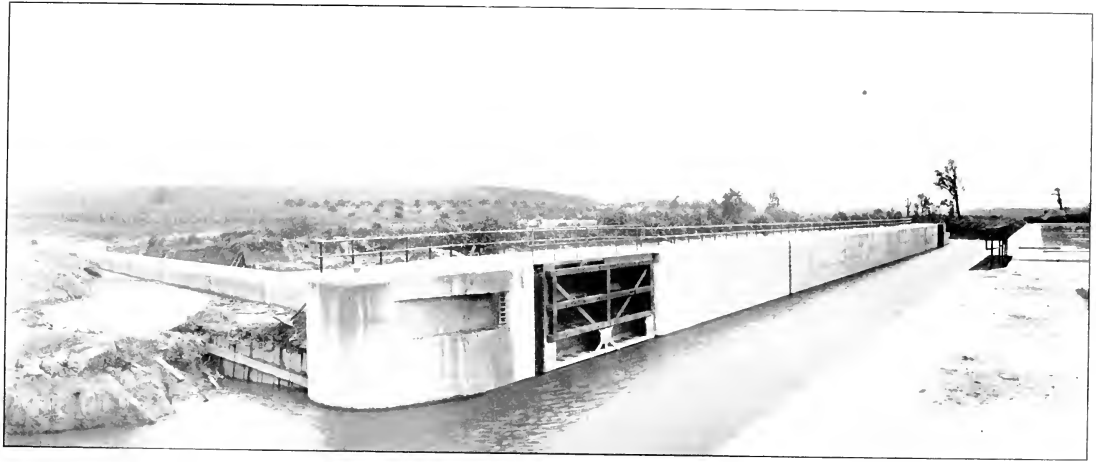
Outlet of by-pass culvert at lock No. 33, near Rochester. The water emerges through the two 5-foot pipes and its fall is broken by the heavy riprap. The view shows also a concrete foot bridge.

Draft tube forms for power plant at lock No. 23.

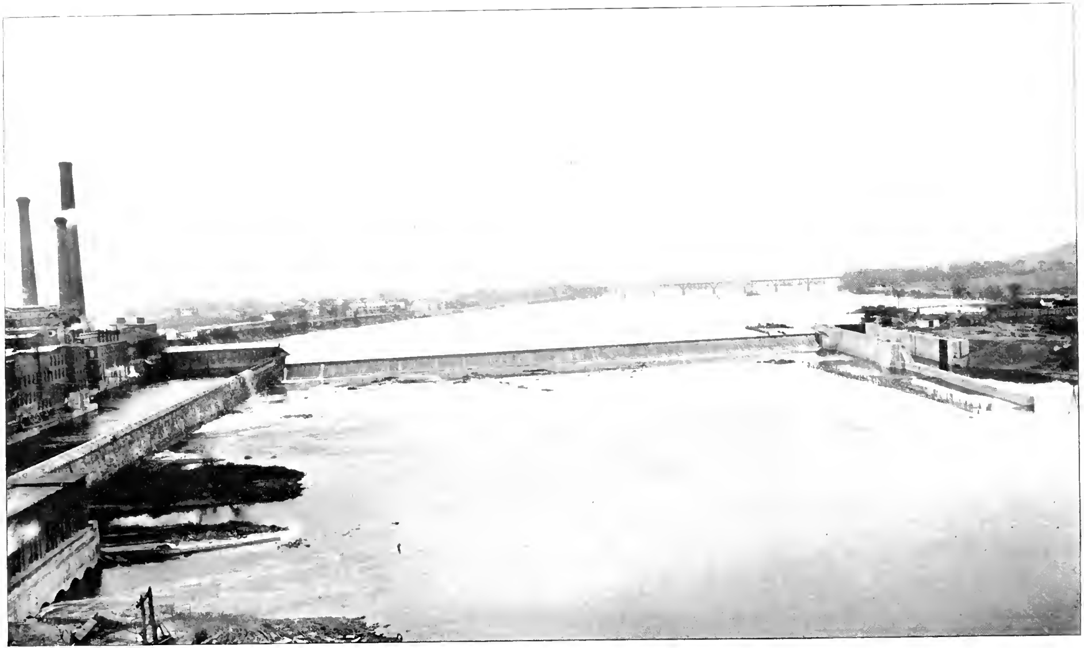


Power house at lock No. 24, at Baldwinsville.

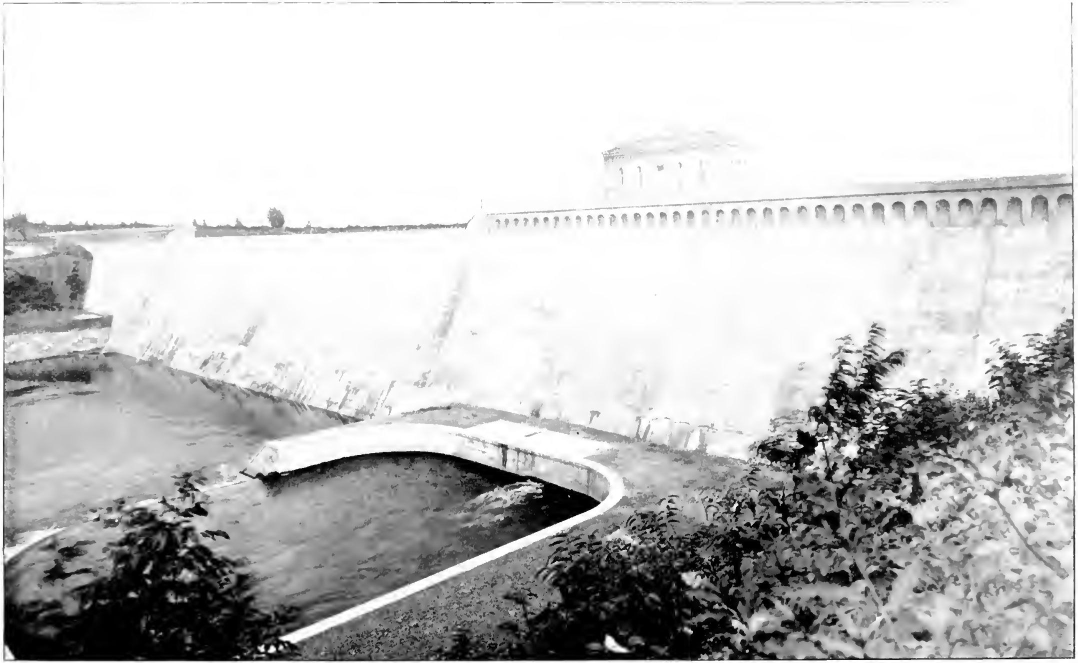
Progress on electric installation for operating machinery at the siphon lock at Oswego.



Lock No. 26 and dam in Clyde river, near Clyde.

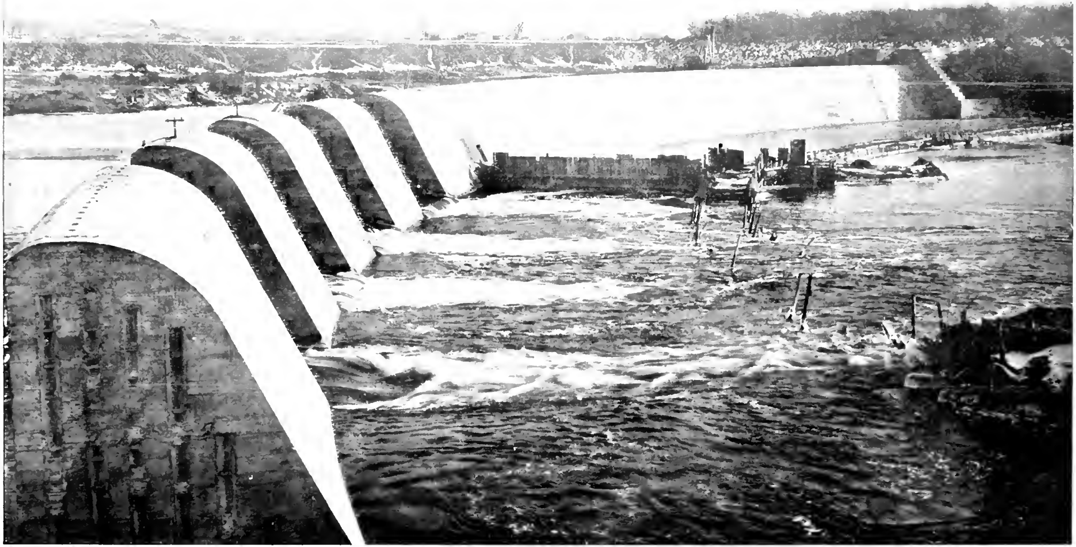


View at Mechanicville, showing the Hudson river, which has been canalized by utilizing an existing dam and building a lock where a portion of the dam was cut away.

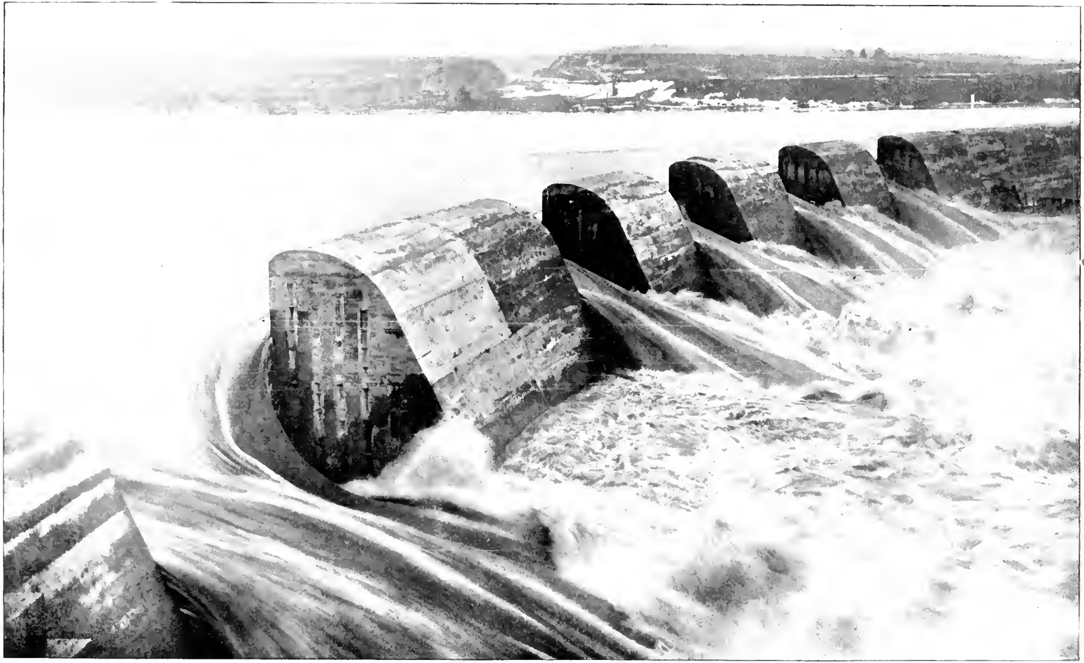


View of the completed Delta dam, showing the spillway section in the center with a pool at its base; also the gate house over the feed pipes, through which water is seen to be flowing and discharging into a pool of higher elevation than the adjacent river level.

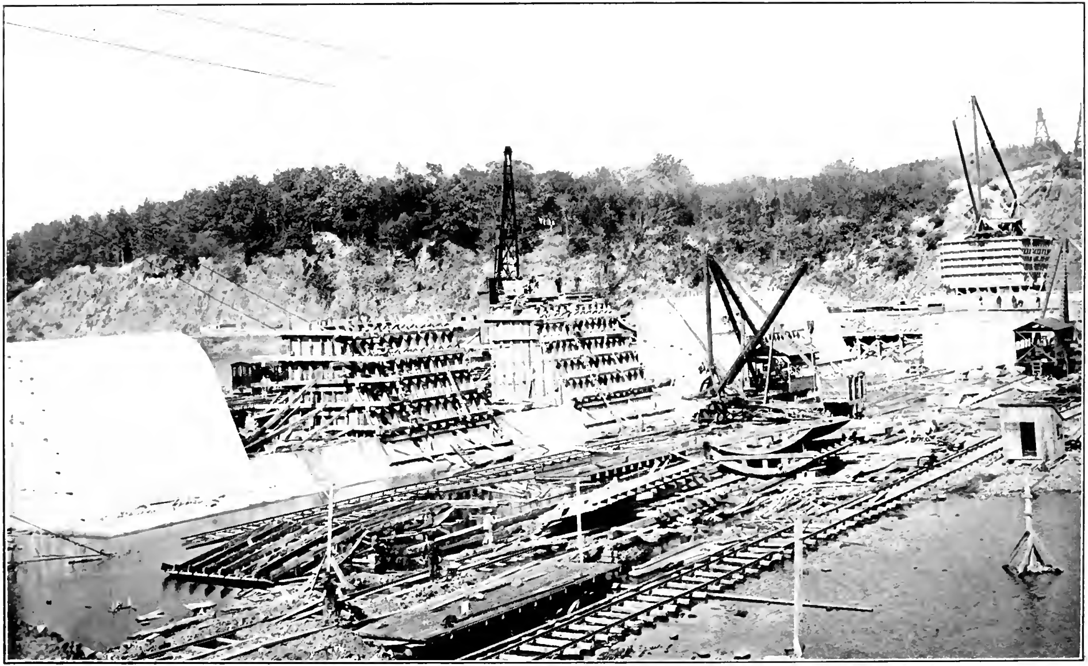
View of the completed dam at Delta reservoir, showing the partially filled reservoir.



Eastern portion of the dam at the foot of Mohawk river navigation, known as Crescent dam. The open sections were left for the flow of the river while the other portion was being built.

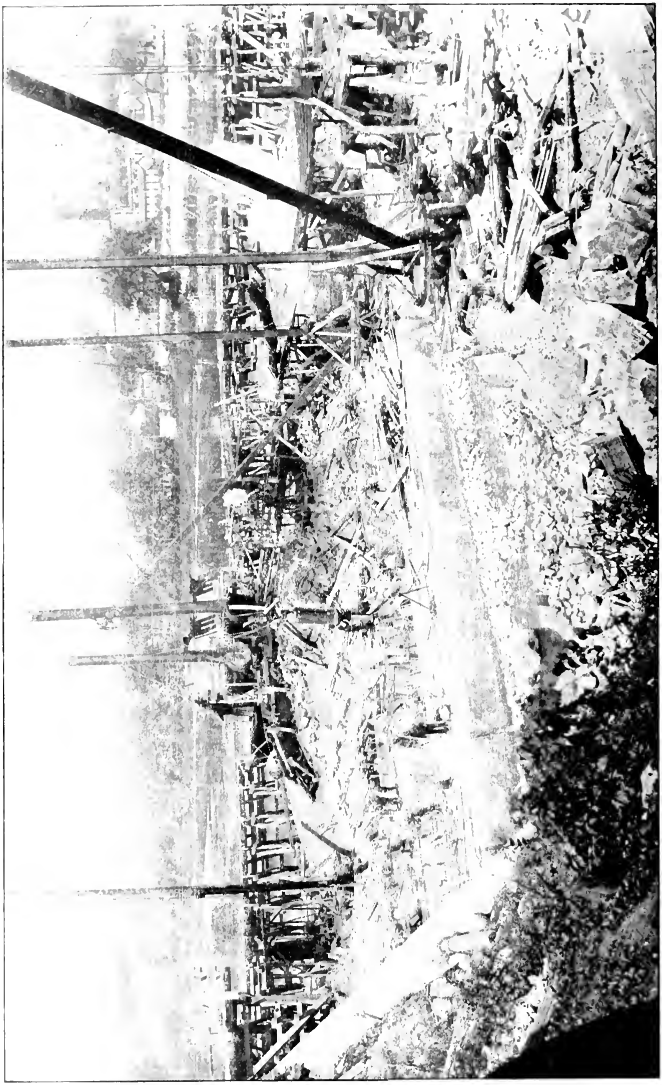


Eastern portion of the Crescent dam, with completed alternate sections, during spring flood. The cut for the canal channel is seen in the farther bank.

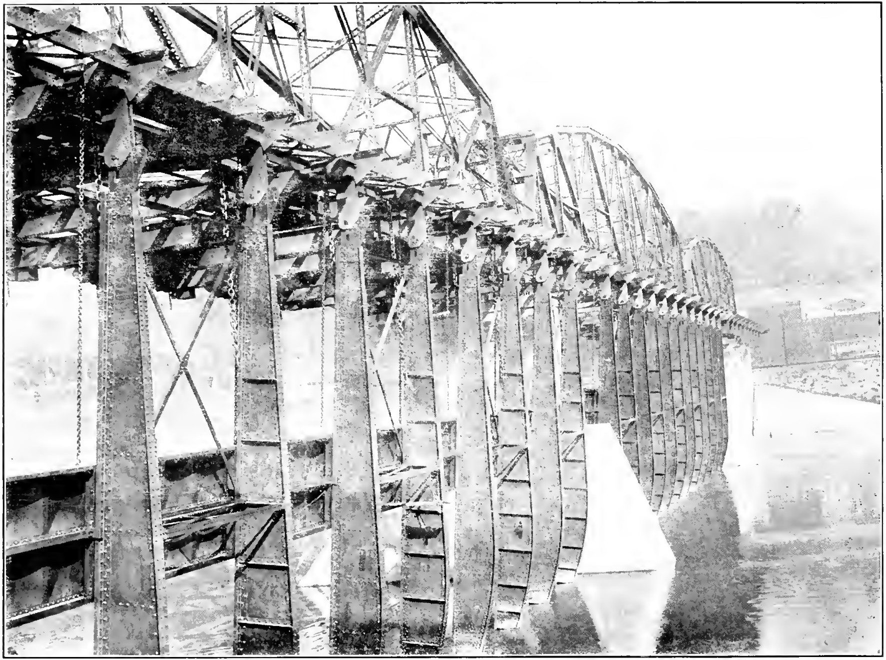


Northern portion of Vischer's Ferry dam during construction.

View of completed northern portion of Vischer's Ferry dam, showing also the head gates at the farther end.



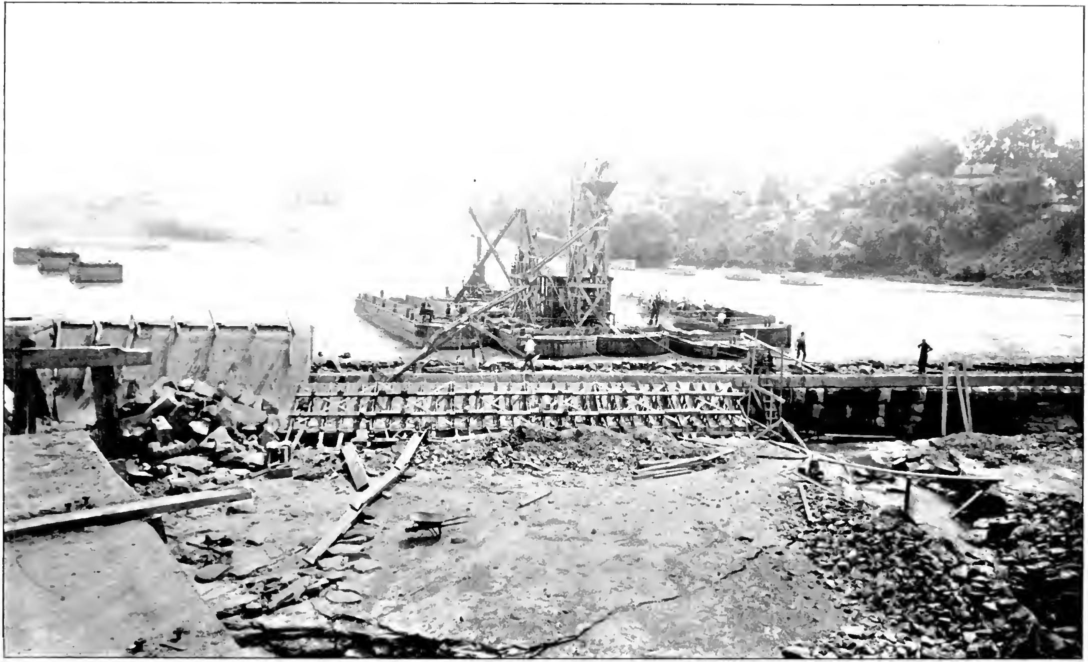
Construction of the concrete sill of the movable dam of bridge type at Amsterdam.



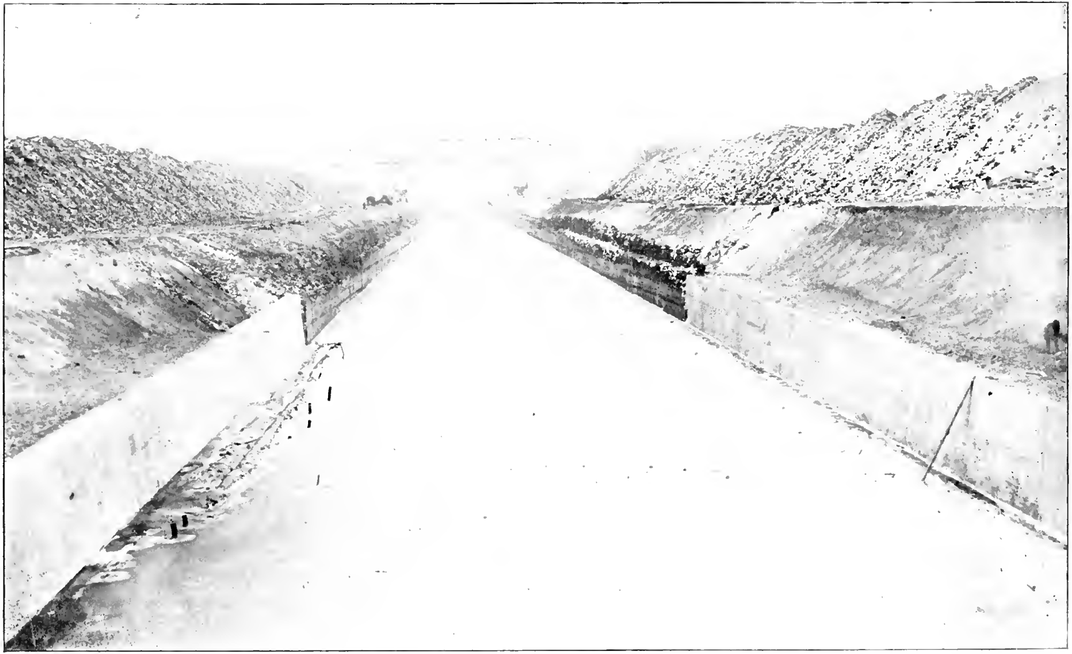
Near-by view of the movable dam of bridge type at Cranesville, showing details of construction. View taken when the upright gate frames had been suspended beneath the bridge floor and the upper tier of gates had been placed.

General view of the lock and movable dam of bridge type at Tribes Hill. The gates and uprights are all raised, ready for winter and flood conditions.

View showing progress in constructing the lock and movable dam at Scotia. Here it was found necessary to use pneumatic caissons for laying the foundations. The caissons for lock walls are seen near the left bank, while caissons for dam piers and sills stretch across the river.



Raising the upper dam at Fulton by topping out and facing with concrete the old masonry dam. A floating concrete mixer was employed.

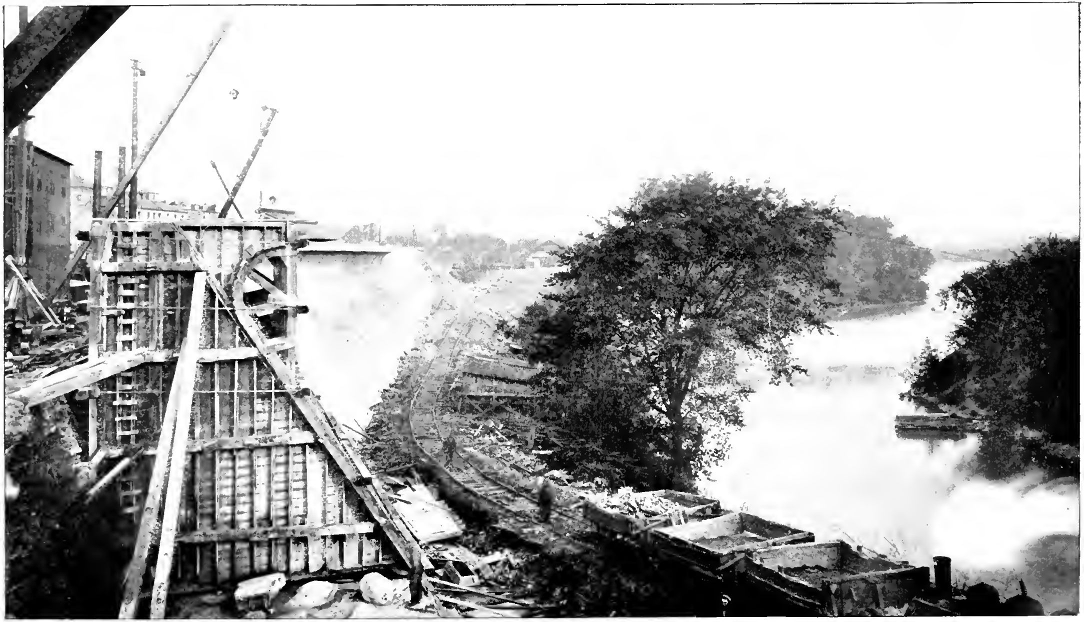


Section of channel near Rochester, with vertical walls in the foreground and rock excavation, channeled below water line, in the distance.

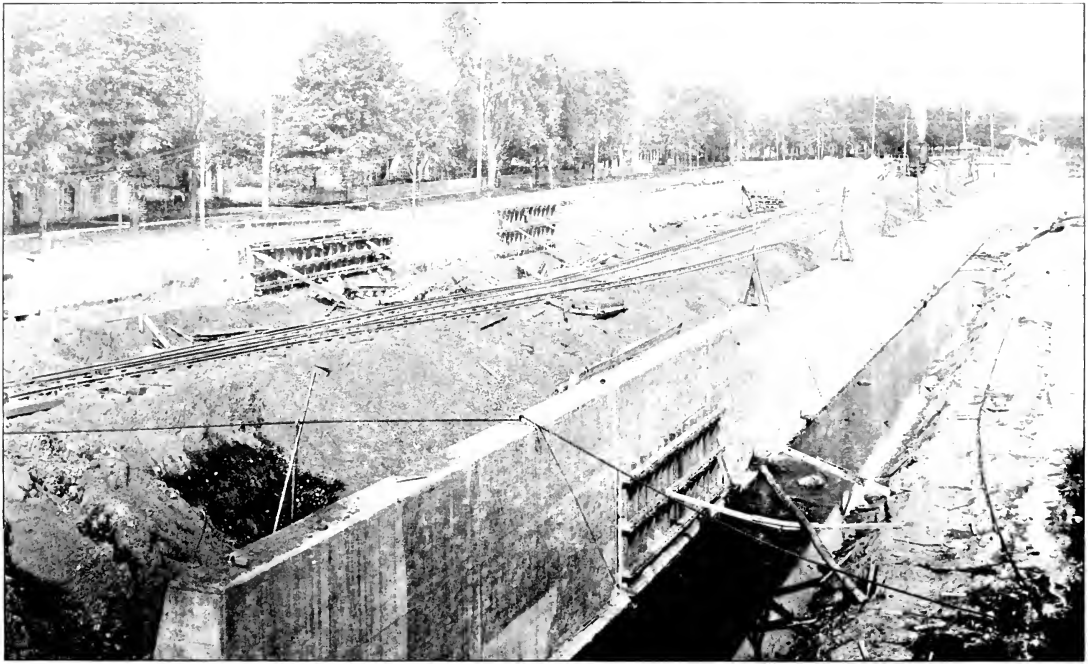
Section of channel in embankment.

Section of channel in deep cutting.

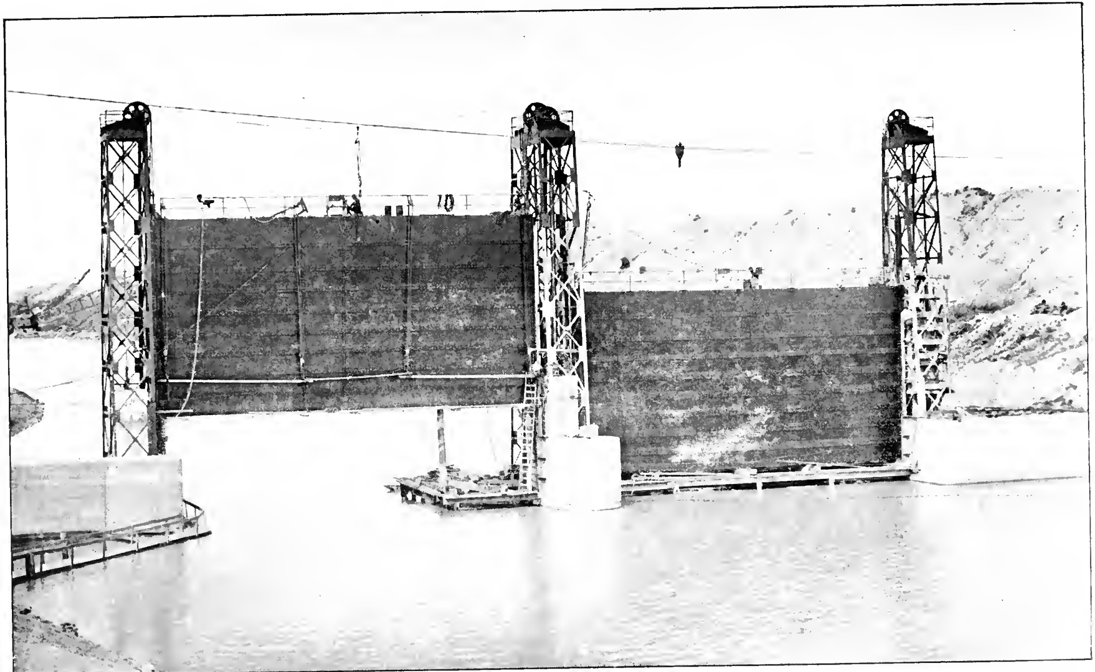
The canal alignment just east of the Genesee river and south of Rochester passes through a hill that requires a cut of 63 feet at its greatest depth; then it traverses low ground, upon which there must be an embankment, a maximum of 42 feet to top of side banks being necessary.



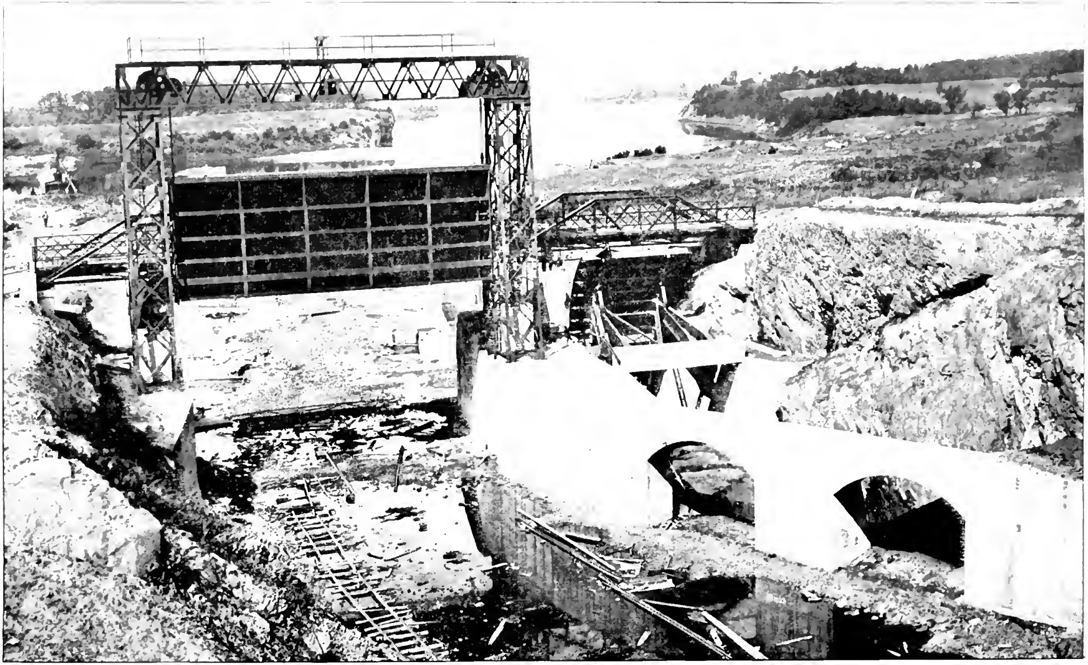
Progress of canal construction at Medina. The alignment circles a deep gorge and necessitates considerable high wall. The canal in effect will be running for nearly a third of a mile behind a dam which reaches a maximum height of 45 feet.



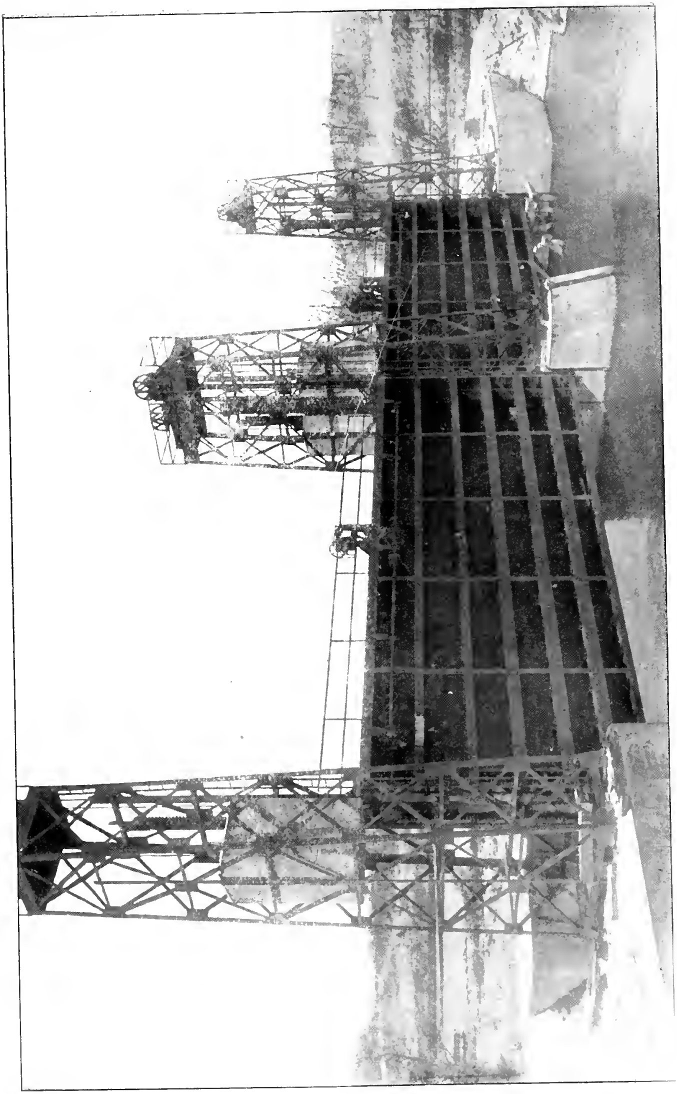
Construction of dock at Newark, between East avenue and Main street. View shows one of the approaches and the retaining wall between Van Buren street and the dock.



The guard-gate near Pendleton. This structure protects the canal against a destructive inflow from Lake Erie in case of a break in the Lockport locks.

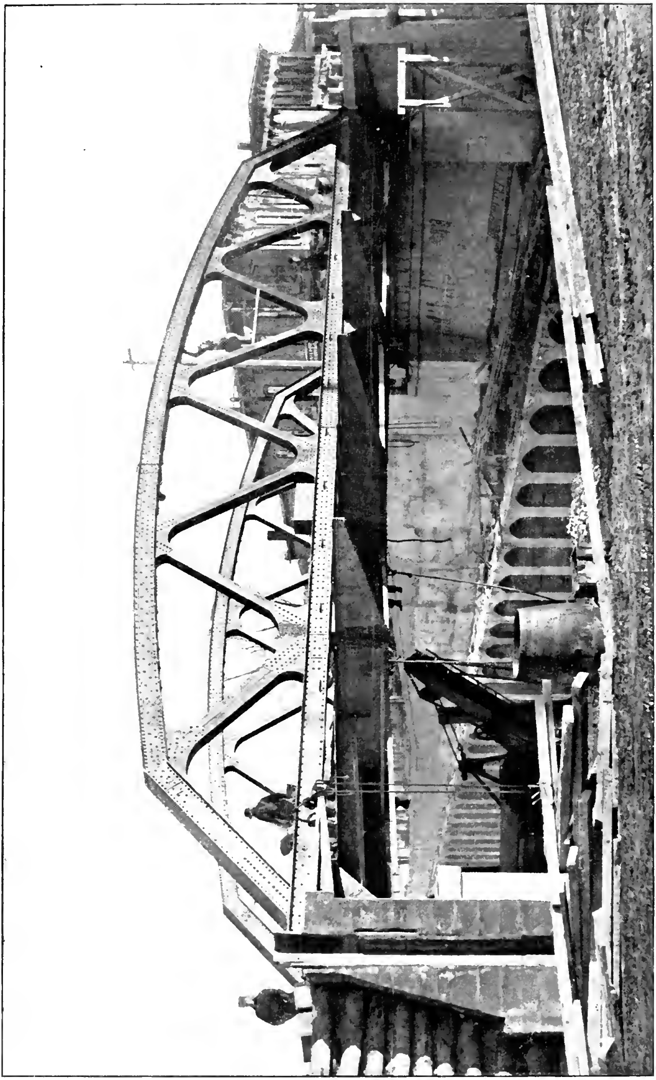


Guard-gate, Taintor gate by-pass and bridge at head of land line between Hudson and Mohawk rivers.

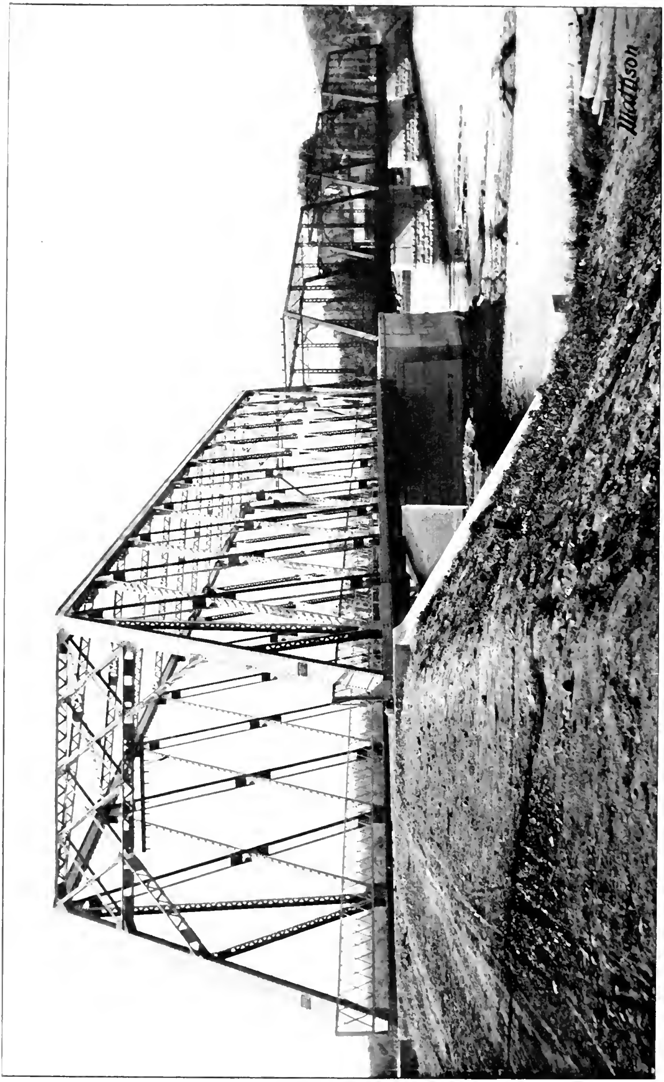


Guard-gate at Rocky Rift, a little east of Little Falls.

Highway bridge over the new channel a little east of Oneida lake.



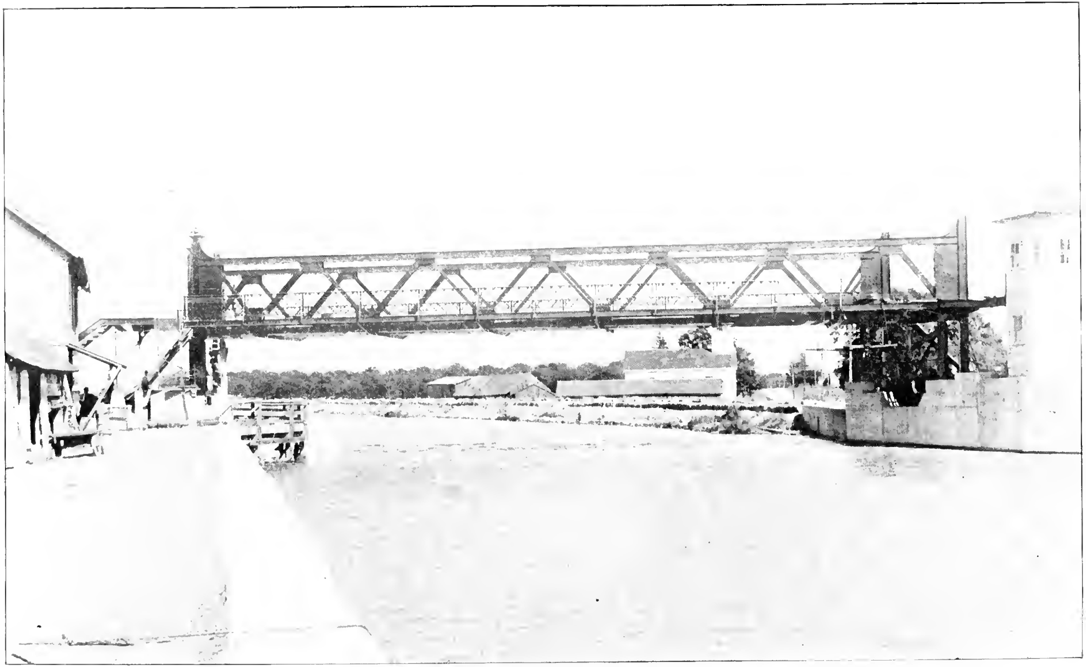
Bridge at the foot of lock No. 24, Baldwinsville, built for highway and trolley traffic.



Highway bridge at Mosquito Point; one span over the canal channel and three spans over the Seneca river channel.

Knapp's bridge, near Fairport, crossing canal and West Shore and New York Central railroads.

Highway bridge at Brooks avenue, near Rochester, over new land line channel in deep cutting.



Lift bridge over the enlarged channel at Eagle Harbor.

North abutment, Main street bridge, Lockport. Local conditions, which make of this bridge a public square in the center of the city, demand a peculiar structure. It is a three-hinged, deck, plate-girder, arch bridge, with a span of 116 ft. 10 in. between end pins and a rise of 12 ft. between center and end pins. Its width, 475 ft., takes in two streets and the block between. To secure proper clearance above water surface and not elevate the street grade, a unique form of girder was designed, as shown in the view. Instead of being uniformly arched, it has an angular shape at the outer end.

Concrete arch bridge at Broadway, Fulton. The first span, built by the State, crosses the Oswego canal at the foot of lock No. 2; the four other spans, built by the city, cross the Oswego river.

Section of completed prism near Gasport — typical of stretches in the western part of the state, where the channel is generally a land line and consists in an enlargement of the old canal.

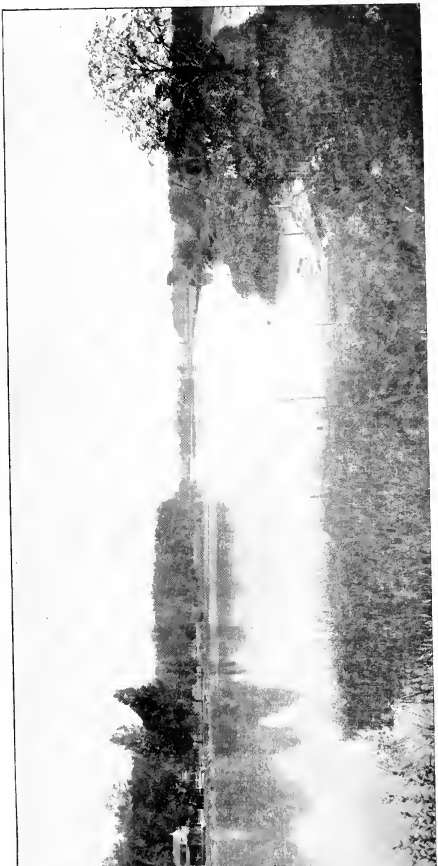
Completed channel, typical of the Rochester-Lockport level, where in general the alignments of the Barge canal and the present canal are identical.

View of completed canal, looking towards lock No. 2, at Waterford.

View of completed canal, looking towards lock No. 3, at Waterford.

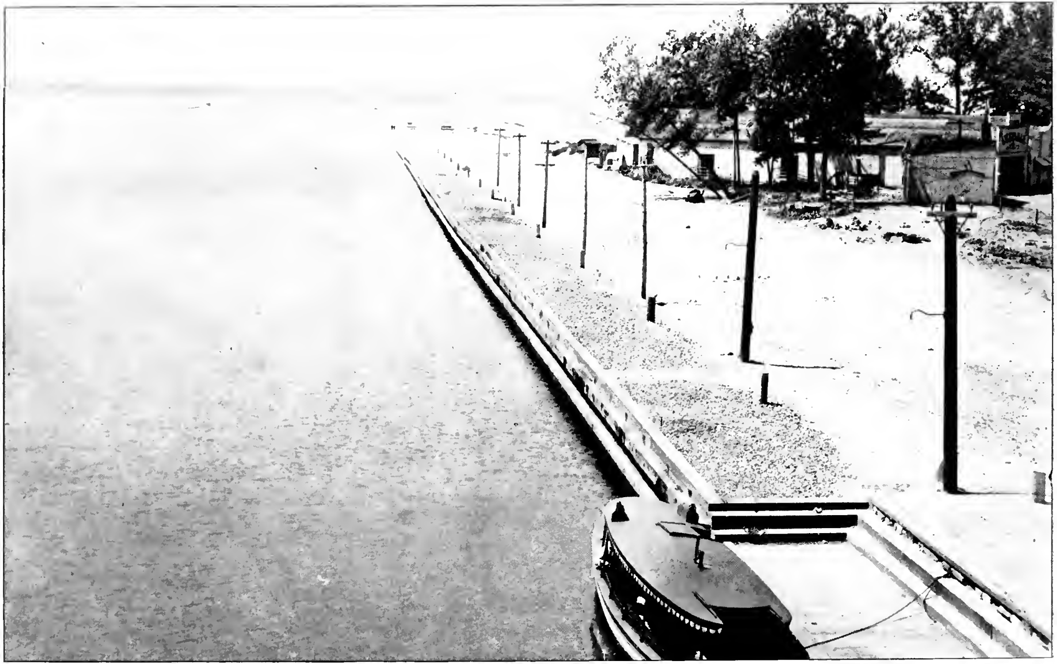
Completed canal just below lock No. 3, at Waterford.

View of the canal in the vicinity of Newark.

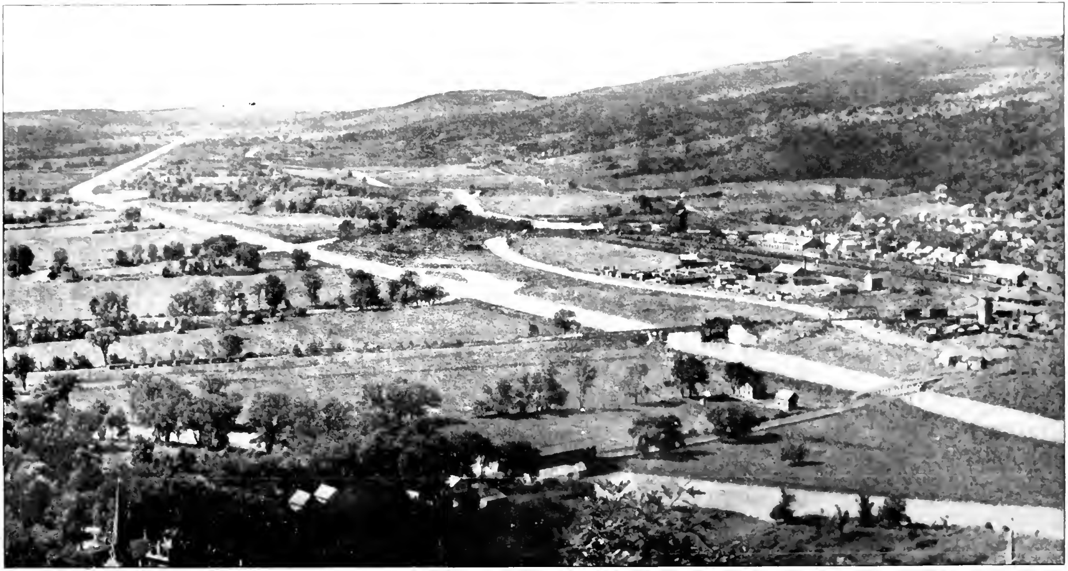


View of a river channel in the Oneida river a short distance above Three River Point.

Entrance into a land line from the Hudson at Fort Miller.



Completed pier at Sylvan Beach, at the entrance of the Barge canal into the eastern end of Oneida lake.



Bird's-eye view from a hill in Whitehall, showing six miles of completed Barge channel at the north end of the Champlain canal; also the old canal at the right and Wood creek crossing and recrossing the new canal.